FINAL PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT FOR DEFENSE THREAT REDUCTION AGENCY (DTRA) ACTIVITIES ON WHITE SANDS MISSILE RANGE, NEW MEXICO

FINAL

Volume I

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Abstract: This Final Programmatic Environmental Impact Statement (PEIS) comprehensively addresses proposed Defense Threat Reduction Agency (DTRA) activities at White Sands Missile Range (WSMR), New Mexico. It addresses future DTRA testing activities and expands on the current testing parameters addressed in existing National Environmental Policy Act (NEPA) documents. It includes a review of current operations and would serve as an environmental reference for future planning and development of various programs.

The proposed action (and preferred alternative) is comprised of nine activity-related categories: 1) collateral effects testing using simulant materials; 2) rock penetration testing; 3) hard target lethality and defeat testing; 4) advanced weapons lethality testing; 5) static high explosives testing for target lethality; 6) weapons effects testing using the Large Blast/Thermal Simulator; 7) anti-terrorism testing; 8) development of weapon effects targets and test beds; and 9) improvements to the Permanent High Explosive Test Site (PHETS) Administrative Park. The no action alternative would effectively cap the magnitude and extent of DTRA activities on WSMR and reduce the Department of Defense capability to control and eliminate weapons of mass destruction.

The Final PEIS analyzes the environmental consequences of the proposed action and the no action alternative. Environmental subject areas include soils, water, biological resources, cultural resources, airspace, air quality, socioeconomics, and infrastructure.

A 60-day comment period beginning *January 27* and ending *March 28, 2006* was made available, in which the public had an opportunity to comment on the Draft PEIS. All comments have been addressed in the Final PEIS.

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SUMMARY

Introduction: The Defense Threat Reduction Agency (DTRA) was established in 1998 to assist in safeguarding the United States and its allies from weapons of mass destruction (WMD). DTRA maintains a number of test beds and target types at White Sands Missile Range (WSMR), New Mexico, to support Department of Defense (DoD), Federal agencies, and friendly nations' programs to counter proliferation of WMD. One of the DTRA legacy agencies, the Defense Nuclear Agency (DNA), which was later known as the Defense Special Weapons Agency (DSWA), has operated and maintained test beds and related infrastructure at WSMR since 1976.

As part of its mission, DTRA evaluates the ability to counter and defeat WMD (chemical, biological, radiological, nuclear, and high explosives). The agency maintains a broad spectrum of target types on its test beds (many of them mock-ups of WMD facilities) and directs the development and implementation of new weapons technologies against these targets.

To evaluate weapon defeat capabilities and further sensor development for WMD agents, simulant test materials are used that have *similar* characteristics to the weapons materials but are either non-hazardous or much less hazardous. When a mock WMD facility containing simulants is destroyed in a test on WSMR, the airborne simulant plume is tracked and analyzed to obtain models for the behavior of actual WMD plumes so as to better plan for a real scenario and help reduce non-combatant casualties.

DTRA also conducts tests to evaluate warhead penetration through bedrock and deep soil against mock enemy target structures. For example, Hard Target Defeat testing analyzes the means to penetrate and destroy targets buried within rock structures (bunkers). Large- and small-scale high explosive (HE) tests are also conducted on DTRA test beds. At WSMR, DTRA currently operates the Large Blast/Thermal Simulator (LB/TS), Permanent High Explosive Test Site (PHETS), Seismic Hardrock In Situ Test Site (SHIST), Alternate SHIST Site (Alt. SHIST), and the Capitol Peak Hard Target Defeat (HTD) Test Bed.

This draft Programmatic Environmental Impact Statement (PEIS) comprehensively addresses future DTRA testing activities and expands on current testing parameters at DTRA's WSMR locations. The timeframe for future actions under this document is approximately 10 years. Analysis in this draft PEIS emphasizes potential environmental effects on the northern part of WSMR, which is the area most used by DTRA.

Purpose and Need: The purpose of the proposed action is to provide adequate test areas and facilities to evaluate the lethality effectiveness of weapon systems used against simulated enemy ground targets producing, storing or controlling weapons of mass destruction (WMD).

There is a need to improve weapon systems designed to defeat enemy military assets, including hardened and reinforced structures. These enemy military assets can house WMD and pose a significant threat to international stability and peaceful coexistence among nations. The military structures and equipment of the United States and its allies, alternately, must also be refined to better withstand attack by enemy weapon systems.

Proposed Action (Alternative One): The proposed action (Alternative One) is the preferred alternative. The proposed action encompasses expanding existing test beds and creating new ones; expanding the range of test types, including targets, simulants, delivery systems and explosives; and, implementing infrastructure improvements at the PHETS Administrative Park.

The proposed action includes testing of special weapons and delivery systems, and the expansion and/or improvement of existing weapon effects test facilities that have been explained in the following nine generic areas. The categories are:

1) Collateral effects testing using chemical, biological, and radiological (CBR) simulants;
2) Hard rock penetration testing;
3) Hard Target Lethality and Defeat testing;
4) Advanced weapon lethality testing;
5) Static high explosive (HE) testing for target lethality;
6) LB/TS weapons effects testing;
7) Anti-terrorism tests;
8) Development of weapon effects targets and test beds; and
9) Improvement to the PHETS Administrative Park

In summary the nine action categories address the following: the use of new and larger amounts of (CBR) simulants; continued testing of existing concepts at new sites using existing and new weapon designs; location and use of new sites; and improvement to existing test bed infrastructure.

DTRA currently uses extensive areas in the northern part of WSMR where hardened and special WMD targets are built as mock-ups of enemy military structures and various weapons are tested against these targets. Hardened targets are well protected, often deeply buried structures that include reinforced concrete bunkers and tunnels excavated into mountains. Weapons currently tested are mainly air-delivered bombs and missiles in the current U.S. arsenal and developmental weapons. Some future tests would involve the use of CBR simulants. In these tests, the simulants placed inside mock production facilities would be released when the structure is attacked allowing the dispersal patterns of the airborne simulants to be analyzed to predict the patterns of actual WMD agents. This experimental data is used to validate predictive codes used to determine and minimize the exposure to non-combatants near a real-world facility following attack. Through the on going testing supported by DTRA, weapon systems are continually being developed and improved to defeat hardened targets and reduce the threat of WMD.

Some DTRA test beds would be used for static high explosive tests (detonating from a fixed position on the test bed). PHETS was created primarily to provide a location for conducting HE tests consisting of igniting above and below ground static charges. Proposed large-scale static HE tests (primarily using many tons of ammonium nitrate-fuel oil [ANFO]) would be designed to evaluate the survivability of military assets against simulated enemy nuclear blasts and to calibrate equipment used to verify compliance with the Threshold Test Ban Treaty of 1974. Proposed small-scale tests would be conducted to obtain the explosive characteristics of various system components and require smaller quantities of explosives.

Advanced weapons testing in the near future would include the possible use of lasers, electromagnetic pulse devices (EMP), and unmanned ground (UGV) or air (UAV) vehicles. Anti-terrorism tests would be conducted using a mock-up government building at PHETS to obtain survivability data after the detonation of simulated terrorist explosive devices or for examining the characteristics of various improvised explosive devices (IED). The proposed action also encompasses expanding test beds and creating new ones, and implementing infrastructure improvements at the PHETS Administrative Park.

The primary DTRA test beds are summarized below:

- LB/TS is an enclosed facility used to evaluate the survivability and vulnerability of full-scale military and other equipment subjected to the air blast and thermal conditions of an enemies simulated nuclear

explosion. The facility can also be used to simulate conventional explosive blast effects against building facades and military equipment.

- PHETS is used for high explosive events and tests to evaluate the effectiveness of various weapon systems against hardened targets. Collateral effects resulting from the release of chemical and biological agents after target defeat is also evaluated at PHETS using simulants and taggants (materials used to track the path of simulant plumes through the air).

- SHIST, and Alt. SHIST sites are used principally for bedrock (e.g., granite, diabase, shale, or limestone) penetration tests using various warhead types. A new limestone test bed would be established at Alt. SHIST. Weapons are typically air-delivered inert and live bombs, and projectiles launched from ground-based vehicles.

- Capitol Peak HTD Test Bed was established to provide realistic hardened tunnel targets. These underground structures are excavated and recessed in bedrock and designed to simulate tunnels used to protect personnel and assets, including nuclear, biological, chemical, and conventional weapons, from attack.

- A new test bed for HTD testing is proposed at Mockingbird South.

Alternatives: Alternative one the preferred alternative would allow DTRA to expand its activities to better meet its mission of reducing the threat of WMD by the utilization of the weapons effects testing at WSMR. Alternative two contains all the actions described in alternative one plus the addition of chemical simulants and taggants/tracers that are considered to have higher toxicity levels than those considered under alternative one. Alternative two would provide a broader selection of chemical simulants available for collateral effects testing, providing greater security in reducing the threat of WMD but would pose a higher risk to human health and the surrounding environment than those under alternative one. The increased hazard of these chemicals, lead to identifying Alternative one as the preferred alternative.

The no action alternative would effectively cap the level of DTRA activities to the extent that development of threat reduction technologies would be seriously constrained. The no action alternative would limit the activities at present levels until existing environmental documentation expires.

Alternatives considered but not carried forward for further analysis include: the establishment of alternate testing facilities elsewhere than WSMR, the use of computer modeling and simulations exclusively, and elimination of DoD weapons testing focused on reducing the threat of WMD. Test ranges other than WSMR could be used for many of the tests described in the proposed action; however, none of the other test ranges provide the needed space and infrastructure in one place, as WSMR does, to support these programs.

Computer modeling and simulation (especially regarding collateral effects tests) is an important tool for generating weapons effects testing data for control of WMD. This approach by itself, however, is insufficient in that it must be validated by field-testing of the models and simulations.

The elimination of DoD development and testing of weapons to reduce the threat of WMD was suggested at a public information meeting regarding the PEIS. This alternative is a national policy issue beyond the scope of the PEIS. Therefore, this alternative was excluded from further consideration.

Environmental Consequences: Impacts to the environment from the proposed action and no action alternative are analyzed in the PEIS in the following categories: physical resources (further subdivided into topography, aesthetics and visual resources, climate, geology and soils, seismicity, and water resources); biological resources; cultural resources; land use; airspace; air quality; noise and blast; radiation; hazardous waste; human health and safety; and socioeconomics and infrastructure. The major factors used to evaluate environmental consequences consist of the following: *resource sensitivity* (the probable response of the resource to an action; *resource quality* (the present condition of the resource potentially affected); *resource quantity* (the amount of the resource potentially affected); and *duration of impact* (the time over which the resource would be affected). An additional category is cumulative impacts, which are incremental impacts of a proposed action when added to the other past, present, and reasonably foreseeable future impacts regardless of the agency or entity undertaking the action.

1. Topography

Under the proposed action, topography would be affected on the DTRA test beds where new target structures are to be constructed. Buried or partially buried bunker targets may be constructed at PHETS that would alter the local topography. Additional tunnel targets are proposed for the expanded Capitol Peak HTD test bed and a new test bed at Mockingbird South. Tunnel construction would create piles of ramped earth at portal

entrances, and mounds of earth material are also expected on test beds from the emplacement of berms and firing pads. Weapon detonations and recovery of inert warheads on DTRA test beds would create craters and pits that could temporarily alter the landscape. In particular, detonation of 500-ton TNT equivalent explosive would disturb the ground near tunnel targets at the Capitol Peak HTD test bed, resulting in localized topographic changes from the creation of craters (see Section 4.1.1 Impacts to Location and Topography).

The no action alternative would not result in additional impacts to topography within the DTRA test beds. Additional tunnel targets at the Capitol Peak HTD and Mockingbird South test beds would not be built; SHIST, Alt. SHIST, and Capitol Peak HTD test beds would not be expanded; a 500-ton equivalent test would not occur at Capitol Peak HTD test bed and the DTRA mission to reduce the threat of WMD would be seriously impaired.

2. Aesthetics and Visual Resources

Impacts to aesthetics and visual resources from the proposed action would result mainly from target construction, explosive tests, and test bed expansion. Additional tunnel targets at Mockingbird South would detract from the largely natural appearance of the area. Construction of berms, hardened targets, and nonpermanent structures at PHETS would be visible from certain local roads and also generate visible amounts of airborne dust. Craters from explosive tests and pits excavated to recover inert warheads would create obvious blemishes on the landscape to observers. Where craters and pits are filled in, the lack of vegetation still indicates where testing has occurred. Expansion of test bed boundaries would increase the overall area subject to testing related disturbances (i.e., target construction, crater formation, etc.).

The no action alternative would marginally reduce the overall effects to aesthetics and visual resources compared to the proposed action. Additional tunnel targets at Capitol Peak HTD and Mockingbird South test beds would not be built, and SHIST, Alt. SHIST, and Capitol Peak HTD test beds would not be expanded. Lower-magnitude explosive tests would also create fewer and smaller craters on the test beds.

3. Climate

The proposed action would include the use of several identified greenhouse gases (for examples, sulfur hexafluoride, carbon tetrafluoride, and bromine trifluoride) for collateral effects tests. For certain other tests, burning plastic, tires, and other materials generate carbon dioxide, another greenhouse gas. The very small amounts of these gases released

during DTRA activities would have no significant effect on climate at any scale. The no action alternative is essentially the same as the proposed action (no significant impact).

4. Geology and Soils

Geology and soil resources vary considerably between the DTRA test beds. Bedrock at PHETS and LB/TS is deeply buried and would be essentially unaffected by DTRA activities. Earth penetration tests at SHIST and Alt. SHIST would impact localized areas of granite and limestone bedrock but would not affect this resource on any larger scale. Excavation of additional tunnel targets at Capitol Peak HTD and Mockingbird South test beds would require the removal and disposition of substantial volumes of waste rock. Subsequent testing against these targets after construction would also disturb bedrock in the two test beds.

There are no unique geologic features at any of the DTRA test beds that would be affected by DTRA activities. Material assayed near Capitol Peak, which lies within the historic Salinas Peak mining district, had low concentrations of mineral resources (McLemore, 2002). No commercially valuable mineral resources are expected to occur in these areas. Concrete, sand, and gravel used for construction would have a small impact on geologic resources such as limestone and sand deposits.

Explosive detonations, hard rock penetration warhead tests, and excavation activities for target construction would have an effect on surface and near-surface soil horizons throughout the DTRA test beds. Soil compaction from construction equipment usage would increase the potential for soil erosion in the affected test beds.

Soils in the northern part of WSMR are subject to wind and water erosion. Wind erosion (and dust generation) would be a hazard throughout DTRA test beds where ground-disturbing activities occur. Water erosion would be a slight to moderate hazard on most of the DTRA test beds, although areas with steeper slopes would have greater potential for sheet and gully erosion. Wildfires started inadvertently through DTRA activities would also potentially lead to accelerated erosion from creation of bare soil areas.

Soil chemical and biological characteristics would not be significantly affected from DTRA activities, including the use of chemical, biological, and radiological (CBR) simulants for collateral effects tests. Biological simulants, such as *Bacillus thuringiensis* (Bt) and *Bacillus subtilis* var. *niger* (Bg), are the same types of bacteria that occur naturally throughout the environment and will not displace the native microbial populations. Other biological simulants would rapidly decompose or are non-infectious.

Chemical simulants or test materials have mostly low propensity to adsorb to soil and would dissipate readily into the air. Others may be conveyed downward with percolated water; however, most of these test materials degrade rapidly in the soil environment, and the potential for accumulation is low. Radiological simulants are non-radioactive and would not be harmful to existing soil microbes.

The no action alternative would result in less overall disturbance to geology and soils than would occur under the proposed action: additional tunnels at Capitol Peak HTD and Mockingbird South test beds would not be built; and SHIST and Alt. SHIST would not be expanded. Lower magnitude explosive tests would also cause less damage to rock and soil.

5. Seismicity

Seismicity relates to movements within the earth that can cause earthquakes. Geologic faults in the region that includes the DTRA test beds have low seismic activity (not prone to generating earthquakes) and would be essentially unaffected by large-scale HE tests. (The term “seismic” in SHIST and Alt. SHIST refers to the designation of these test beds originally for calibration of earth-monitoring equipment for nuclear explosion detection worldwide). Neither the proposed action nor the no action alternative would have an effect on seismicity with regards to generating earthquakes.

6. Water Resources

DTRA activities would potentially affect water resources on WSMR. Surface water flow may be disrupted locally on test beds after ground disturbance from tunnel target construction, weapon impacts, and warhead recovery. In these instances, surface water runoff from rain events may increase due to an increase in bare ground.

DTRA test beds are at least several kilometers from perennial surface water bodies in Tularosa Basin. Computer models have indicated that collateral effects tests at the Capitol Peak HTD test bed would result in only trace amounts of simulants potentially entering Salt Creek or nearby basin springs.

DTRA activities are not water-intensive and would have little effect on ground water resources in the region. Most of the water needed to support the proposed action would be transported by truck from WSMR supply wells, mainly Stallion Range Center.

Explosive testing is not anticipated to affect ground water quality on the DTRA test beds. PHETS is the main test bed historically for large-scale tests, and analysis of ground water

samples has not revealed evidence of test-related contamination from explosive residues or unburned explosives. Well water samples near present collateral effects test beds have detected no simulants. Other DTRA test beds are mostly atop bedrock with thin alluvial cover, and there are likely only small amounts of temporary ground water present (i.e., after a substantial rainfall) at the alluvium-bedrock interface with little potential for contamination.

The no action alternative would entail the use of less ground water in that test bed expansion and construction would not be done. Also, a testing schedule at current levels would require less water to support personnel on the DTRA test beds than under the proposed action. CBR simulants would not be dispersed at DTRA test beds (other than PHETS), thus eliminating essentially all potential for simulants from DTRA tests drifting onto regional surface waters.

7. Biological Resources

Collateral effects using simulants may cause plant mortality, impair plant growth, or reduce plant reproductive success in areas close to the dispersion point. However, scientists have not noted visible changes in plants adjacent to test structures after past tests using triethyl phosphate (TEP), an extensively used chemical simulant. (This does not imply that other test materials would have a similar low-impact on plants). Other DTRA testing activities (for example, explosive tests, earth penetration tests, HTD tests, advanced weapon tests, warhead recovery) would disturb or destroy plants within the test bed. Tunnel target construction and test bed expansion would also damage or destroy vegetation locally.

The Todsen's pennyroyal (*Hedeoma todsenii*) is the sole Federal endangered plant species known on WSMR. Populations of this species are many kilometers south of the DTRA test beds and would not be affected by DTRA activities. The San Andres rock daisy (*Perityle staurophylla*), a plant listed as a New Mexico species of concern, has been identified on the Capitol Peak HTD test bed. This species, however, is afforded no special protection status, even though the local population may be damaged or destroyed.

The effects of CBR simulants and other test materials on native fauna are largely unknown; however, a few experiments on model species (in laboratories) have been performed. Most biological simulants (for example, *Bacillus subtilis* var. *niger* [Bg], *Clostridium sporogenes*, and MS2 bacteriophages) do not cause disease and are essentially non-toxic. *Bacillus thuringiensis* (Bt) is a common soil bacteria and is used commercially as an insecticide. Insect mortality from tests using Bt is possible near

DTRA test structures. There is evidence in scientific literature of Bt toxicity for certain birds and fish.

Chemical simulants have not been widely tested on wildlife species, but laboratory data indicate that most have high lethal dose/ lethal concentration values (relatively large amounts of simulants are needed to cause mortality in sample populations). Some chemical simulants have the potential to bioaccumulate (build up within the tissue of an animal over time). Fish (and other aquatic fauna) are most prone to bioaccumulation, and 10 proposed test materials were identified to have potential for aquatic bioaccumulation.

Earth penetration tests, advanced weapons tests, HTD tests, and explosive tests have the potential to directly injure or kill native fauna from flying debris and blast overpressure. Craters generated from testing and warhead recovery may also pose a trapping hazard to animals. Construction of tunnel targets and test bed expansion through the use of heavy equipment may injure and kill flora and fauna in the areas. Noise from weapon detonations can invoke a startle or panic response in wildlife. Hearing damage to animals is also possible through exposure to large explosions on the DTRA test beds.

There are several faunal species with potential to occur within DTRA test beds in the northern part of WSMR. Mammal species include the desert bighorn sheep (*Ovis canadensis mexicana,* New Mexico endangered); the Oscura Mountains Colorado chipmunk (*Tamias quadrivittatus oscuraensis*, New Mexico threatened); and the spotted bat (Euderma maculatum, New Mexico threatened). The sheep are a species introduced to the San Andres Wildlife Refuge far to the south of the DTRA test beds, and it is unlikely that the sheep would be affected from DTRA activities. The chipmunk occurs at higher elevations in the Oscura Mountains, and testing at SHIST Site would have little effect on these animals. The bat could potentially use the SHIST and Capitol Peak HTD test beds as roosting areas. The use of CBR simulants at these sites has the potential to locally affect insect populations that the bats feed upon.

Bird species that may occur on or near DTRA test beds include the northern aplomado falcon (*Falco femoralis septentrionalis*, Federal and New Mexico endangered); the American peregrine falcon (*Falco peregrinus anatum*, New Mexico threatened); the Baird's sparrow (*Ammodramus bairdii*, New Mexico threatened); and the piping plover (*Charadrius melodus circumcinctus*, Federal threatened and New Mexico endangered). The northern aplomado falcon has not been sighted since the early 1990s on WSMR, and it is presumed that the range does not currently support a resident population. The range of the American peregrine falcon lies mainly to the east of WSMR, where the bird is

deemed rare. The Baird's sparrow is a rare species on WSMR, more likely to be sighted during winter months. The piping plover is a rare spring migrant in New Mexico, with only a few sightings reported for the entire state. It is unlikely that DTRA activities would affect these animals.

The no action alternative would allow DTRA activities to continue at approximate current levels without provisions for expanding testing parameters into the future. This alternative would result in generally less impact to biological resources, in that test beds would not be expanded and Mockingbird South would not be built. Fewer testing events under the no action alternative would also reduce the potential for damage to plants and animals on and near DTRA test beds.

8. Cultural Resources

The proposed action has little potential to affect cultural resources on the DTRA test beds or nearby areas. Collateral effects tests using CBR simulants and other test materials have a small potential to affect radiocarbon (C-14) dates on archaeological materials. However, the amount of simulant materials potentially settling onto the ground downwind from a test event is exceedingly small, and laboratory pretreatment washing of datable samples prior to analysis would further reduce the chance for contamination.

Existing DTRA test beds have been surveyed for cultural resources and known archaeological sites will be avoided from test-related disturbances. Mitigations for potential blast effects on McDonald Ranch House include structural bracing (U.S. Army, 2002b). The proposed new Mockingbird South test bed and the expansion areas at SHIST, Alt. SHIST, and Capitol Peak HTD have potential to disturb cultural resources. However, archaeological surveys will be conducted in previously unsurveyed areas prior to ground-disturbing activities. Thus, the proposed action would prompt additional archaeological surveys that would add to the knowledge base of cultural resources on WSMR.

The no action alternative would lessen potential for damage or disturbance to cultural resources on WSMR. With the decision to scale back testing and to not expand or build new test beds under the no action alternative, there would be less overall potential to affect cultural resources.

9. Present Land Use

The proposed action would continue the use of DTRA test beds primarily for military testing into the foreseeable future. Additionally, certain DTRA test beds are open

occasionally for public access. For example, Trinity Site (where the first atomic bomb was detonated in 1945) and McDonald Ranch (where the first atomic bomb was assembled) are in the PHETS area and are open for bi-annual public tours. Public hunting, regulated through state game laws, is allowed in areas that include the DTRA test beds.

The no action alternative is essentially the same as that of the proposed action with regard to present land use.

10. Airspace

The proposed action for DTRA activities would keep WSMR airspace use at approximately current levels or increase slightly. There would be an increase in number of sorties for air-to-ground weapons tests against DTRA targets (for example, collateral effects tests, HTD tests, earth penetration tests, and advanced weapon systems tests). The anticipated increased use of airspace is well within the capacity of WSMR, and DTRA activities would not significantly affect this resource.

The no action alternative would hold DTRA activities involving WSMR airspace to approximately present levels and would marginally reduce overall effects to airspace compared to the proposed action.

11. Air Quality

Collateral effects testing would release CBR simulant plumes into the air above DTRA test beds. Plume concentrations would dissipate rapidly and reach extremely low levels near the northern WSMR boundary. In the case of biological simulants, spore concentrations would be well below levels of agricultural application. Effects to air quality from simulant releases would be transitory, occurring mainly near the point of release for a short time.

Plume tracers and taggants consist of inert gases and rare earth oxides. These materials, like the simulants, dissipate rapidly upon release, and concentrations would decrease to very low levels as the plume approached the WSMR boundary.

Airborne dust and combustion products (primarily water, nitrogen, and carbon dioxide) would be generated from detonations and impacts related to earth penetration tests, HTD tests, advanced weapon system tests, static explosive tests, and anti-terrorism tests. Construction of tunnel targets at Capitol Peak HTD test bed and the proposed Mockingbird South test bed would generate airborne dust from the use of heavy

equipment. The testing use of LB/TS requires the release of nitrogen gas (essentially inert and the largest component of air).

The no action alternative would result in generally less impact to air quality in the DTRA test bed areas. For example, there would be less test materials released for collateral effects tests and fewer large explosive tests to create dust. Mockingbird South and additional tunnel targets at Capitol Peak HTD test bed would not be built, eliminating sources of construction-related dust. SHIST, Alt. SHIST, and Capitol Peak HTD test beds would not be expanded, again reducing the potential for test- and construction-related dust.

12. Noise and Blast

Static near-surface high explosive and air-delivered bomb detonations from DTRA activities would generate high levels of impulse noise on the test beds. (Impulse noise is an abrupt, loud noise event; an example is an explosion). The effects of noise and blast vary with size of the explosive charge. Many of these detonations would exceed the safe limit for human exposure of 140 DB, requiring the use of hearing protection equipment for personnel in the test area not evacuated. Fauna in the vicinity of an explosive detonation will likely have a startle or panic reaction and leave the area or, if sufficiently close, be killed by the blast.

Aircraft used in DTRA activities will generate noise depending upon aircraft type, speed, altitude, and atmospheric conditions. Typical overflights will last several seconds and generate noise levels of approximately 65-70 dBA. Background traffic noise along roads servicing DTRA test beds typically generates short-duration noise of approximately 70 dBA.

Construction noise would be generated from building additional tunnel targets at Capitol Peak HTD test bed and a new test bed at Mockingbird South. Heavy equipment creates sufficient noise to require operators to don hearing protection equipment. Tunnel target construction may require detonation of explosives during excavation, creating impulse noise.

The no action alternative would result in less noise and blast on the DTRA test beds: large explosive events such as the 500-ton TNT equivalent test would not be detonated at Capitol Peak HTD test bed; Mockingbird South and additional tunnel targets at Capitol Peak would not be built; and test bed expansion would not occur. This alternative would reduce overall effects of noise and blast compared to the proposed action.

13. Radiation

Ionizing radiation sources include instrumentation in large static explosive tests and chemical agent detectors for collateral effects tests. These instruments emit low levels of alpha-radiation that pose little health hazard. However, radiological simulants proposed for testing are not radioactive (do not produce ionizing radiation). Sources of non-ionizing radiation related to DTRA activities include laser guidance and tracking systems, and radar guidance and tracking systems.

The no action alternative is essentially the same as that of the proposed action.

14. Hazardous Materials and Hazardous Waste

The most common types of hazardous waste that would be generated from the proposed action are paints and solvents used for equipment and building maintenance. CBR simulants and other test materials would be used in the smallest amounts practicable so as to reduce the amounts of possible excess hazardous wastes. Used oil from vehicles, construction equipment, generators, and fuel storage units is solid waste and usually recyclable.

The no action alternative would result in generally less hazardous waste and materials from DTRA test beds. For example, less test materials would be released from collateral effects testing, fewer and smaller-scale explosives would be used, and fewer vehicles and construction equipment would be used.

15. Human Health and Safety

DTRA activities pose little hazard to humans living in areas adjacent to WSMR. For collateral effects tests, personnel would handle and have contact with CBR simulants and other test materials during test preparations, post-test evaluations, and site clean up. Personal protection equipment will be used in these situations in accordance with safety regulations. CBR simulant plumes having dispersed over long distances would pose little hazard to people living in areas outside of WSMR boundaries.

DTRA personnel are often required to travel substantial distances to work on DTRA test beds and are thus subject to risks that include vehicle accidents. In addition, workers are potentially exposed to on-site, work-related risks from the use of heavy equipment and machinery.

Personnel involved in field work in support of DTRA activities would also potentially be exposed to hantavirus risk working in enclosed structures. Exposure to venomous animals and spiny plants while working at the DTRA test beds is also possible.

Visitors to the range for the bi-annual Trinity Site trips, races, hunting, field trips, or other public events are escorted by WSMR personnel or given specific instructions regarding approved routes and areas designated for the given activity. Participants in most of these activities are required to undergo an unexploded ordnance (UXO) briefing and follow specific rules while on WSMR to help ensure their safety and welfare.

There would be generally less impact to human health and safety under the no action alternative. Less test materials would be released and fewer explosive tests would be conducted; additional tunnel targets at Capitol Peak HTD and Mockingbird South test beds would not be built, thus lessening the potential for personnel to be exposed to adverse health and safety conditions.

16. Socioeconomics and Infrastructure

The overall impact of the proposed action to socioeconomics and infrastructure to WSMR and the region as a whole would be small. The proposed increase in the scope of DTRA activities in the northern part of WSMR would be a small, added socioeconomic stimulus. There would likely be a small benefit to businesses and employment levels in nearby communities (for example, Socorro, NM).

The infrastructure of WSMR would remain essentially the same under the proposed action. Anticipated demands on utility items such as electricity, communications, and natural gas are well within the foreseeable capacity. The PHETS Administrative Park septic system would have capacity expanded by approximately 50%. Water requirements at the Park would also likely increase slightly.

The road network that services the DTRA test beds has the capacity for any foreseeable increase in traffic volume under the proposed action. An increase in DTRA testing activities may require more frequent roadblocks of internal WSMR roads and of U.S. Highway 380, but this will only be an occasional and temporary disruption of normal traffic flow.

The no action alternative would result in little change in the socioeconomic and infrastructure environment in the northern WSMR region. The number of WSMR and DTRA employees would remain at approximately present levels, and there would be little

change to regional employment and income levels. The burden on range infrastructure would be similar compared to the proposed action.

Environmental Mitigations: Environmental mitigations would be implemented to lessen adverse environmental effects from the proposed action or alternatives. Examples include application of soil stabilizers to control dust (soil mitigation) and avoidance of archaeological sites (cultural resource mitigation). Table S-1 provides a quick reference to impact analysis and proposed mitigations described by environment/resource in section 4.0 of the PEIS:

Table S-1. Summary of Impact Analysis and Proposed Mitigations

Environmental Resources	Impacts of the Proposed Action (Preferred Alternative)	Impacts of Alternative Two	Impacts of the No Action Alternative	Proposed Mitigation
Physical Resources, Section 4.1	● Minor disturbance to topography and visual aesthetics at the test beds ● Increased erosion, soil compaction, and surface water runoff ● Disturbance of bedrock at the test beds	● The same impact on topography, aesthetics, geology, soils, and water resources as the proposed action	● Less impact to topography, aesthetics, geology, soils, and water resources	● Proposed mitigation to minimize impacts to topography, geology, soils, and visual resources test should limit support vehicles to existing roads and test bed boundaries. Off-road travel should be limited to placement of testing infrastructure, plume tracking and recovery activities using a single path in and out. ● Following the end of their usefulness as test beds, all sites (craters and depressions) should be returned to their approximate original contours. ● Appropriate surface water and erosion control measures should be implemented on at proposed test bed expansion areas. ● Dust abatement measures could include the use of water spray trucks and application of soil stabilizers. The WS-ES land manager may also direct additional measures for dust abatement. ● To address degradation of soil chemical quality an appropriate soil monitoring program should be implemented. ● Ground water should be analyzed annually for particular simulants tested at PHETS. ● Storm water samples should be collected annually and analyzed for the presence of recently-tested simulants used at the Capitol Peak HTD test bed. ● Ground water should be monitored at test sites frequently utilizing large quantities of perchlorate based explosives.

Table S-1. Summary of Impact Analysis and Proposed Mitigations

Environmental Resources	Impacts of the Proposed Action (Preferred Alternative)	Impacts of Alternative Two	Impacts of the No Action Alternative	Proposed Mitigation
Biological Resources, Section 4.2	● A small amount of vegetation would be disturbed or destroyed ● Impairment of plant growth, and reproductive success ● Increased water and wind erosion ● Simulants could affect insect pollinators causing indirect impacts to insectivores and insect pollinated plants. ● Fauna located near test beds could be exposed to simulant materials ● Craters from weapons testing could create a trap hazard for fauna ● Fauna could be injured during test and construction activities ● Noise from construction and test activities would temporarily disturb fauna	● The effect on floral and faunal species would be slightly higher than the proposed action because of increases in simulant toxicity.	● Less impact to biological resources	● To assess the impacts of DTRA activities on flora, Land Condition Trend Analysis (LCTA) data collection plots inside the PHETS boundaries should be sampled annually. ● During static high explosive testing the fire department would be on call to prevent the spread of wildfires. ● Best management practices (BMPs) designed to reduce erosion would be implemented. Examples may include mulching, chemical stabilization, silt fences, reseeding, and diversion berms. ● WSMR floral Species of Interest (SOI) may be given preferential treatment as determined by WS-ES, which may include avoidance or transplanting prior to construction activities. ● To limit potential impacts, WS-ES should be provided a list of individual strains and/or sources of all biological simulants for review, prior to each test. ● To avoid interfering with yucca pollination by the yucca moth, tests using *Bacillus thuringiensis* (Bt) will not take place during the month of June, the peak flowering time of soap tree yucca. ● To protect fauna and habitat support vehicles should use existing roads whenever possible. Off-road travel will be limited to placement of testing infrastructure and recovery activities using a single path in and out. ● If a desert bighorn sheep (*Ovis canadensis mexicana*), a State listed endangered species is seen in proximity to a DTRA test bed, WS-ES will be contacted prior to testing. ● Proposed mitigations for tests that could impact White Sands pupfish (*Cyprinidon tulrosa*) habitat would include periodic sampling of the stream waters containing pupfish to assure little or no impact to aquatic life. ● If a northern aplomado falcon (*Falco femoralis septentrionalis*) is sighted or if DTRA plans to conduct activities in areas classified as suitable aplomado habitat, they will contact WSMR's Environmental Stewardship Division to ensure compliance with the Endangered Species Act.

Table S-1. Summary of Impact Analysis and Proposed Mitigations

Environmental Resources	Impacts of the Proposed Action (Preferred Alternative)	Impacts of Alternative Two	Impacts of the No Action Alternative	Proposed Mitigation
Cultural Resources, Section 4.3	● The proposed action would not significantly affect archaeological resources, given certain mitigation measures are taken ● Radiocarbon dating could be affected by chemical and biological simulants	● The effect on cultural resources from additional simulants would be similar to the proposed action.	● Less impact to cultural resources.	● Proposed mitigation for protection of cultural resources includes avoidance of all known archaeological sites, and conducting archaeological surveys to identify cultural resources in previously non-surveyed areas prior to ground-disturbing activities. ● If the planned level or intensity of HE testing should increase, prior consultations will be held with WSMR cultural resource personnel to determine the appropriate level of increased monitoring of the McDonald Ranch house. ● Proper sample preparation will greatly reduce the chance of stimulant contamination of datable material.
Present Land Use, Section 4.4	● The proposed action would not significantly affect present land use	● Same affect as the proposed action	● Same affect as the proposed action	● In the event that testing activities must be conducted during non-duty hours, Range scheduling and WS-ES will be notified in advance to ensure that no conflicts occur.
Airspace, Section 4.5	● Airspace activities would increase slightly over present levels	● Same affect as the proposed action	● Less impact to airspace	● None
Air Quality, Section 4.6	● Release of simulant plumes, explosive by-products, and dust from test activities ● Construction and testing activities would generate dust and vehicular emissions	● Additional simulants would result in the release of test materials with higher toxicity levels than the proposed action.	● Less impact to air quality	● Proposed mitigation to ensure hazardous quantities of test materials do not exit the range include developing prediction models before collateral effects tests, and monitoring wind speed and direction. With this information a "no go" criteria will be developed for each test. ● A proposed mitigation to minimize dust generated from construction activities would be to apply a dust suppressant when practical to minimize excessive vehicle-generated dust levels, and vegetation cover would be retained on sites wherever possible.
Noise and Blast, Section 4.7	● Personnel and fauna would be exposed to noise from test and construction activities	● Same as the proposed action	● Less impact from noise and blast	● Employees would be enrolled in a hearing conservation program if noise exceeds 85 dBa expressed as an 8-hour TWA and would be required to wear hearing protection. ● Personnel would be evacuated to a safe distance prior to explosive tests. ● To minimize blast pressures effects resulting from high explosive tests over 20,000 lbs, weather and overcast conditions should be monitored and blast predictions be verified with distant off-range measurements.

Table S-1. Summary of Impact Analysis and Proposed Mitigations

Environmental Resources	Impacts of the Proposed Action (Preferred Alternative)	Impacts of Alternative Two	Impacts of the No Action Alternative	Proposed Mitigation
Radiation, Section 4.8	● Testing and support equipment would emit low-levels of ionizing or non-ionizing radiation ● Exposure could possibly result in damage to eyes, skin and organ tissue.	● Same as the proposed action	● Same as the proposed action	● Personnel should comply with safety procedures involving radars and other support equipment that emits non-ionizing and ionizing radiation. Safety zones should be established, and clearly delineated, to exclude entry into areas of hazardous radiation.
Hazardous Materials and Waste, Section 4.9	● Petroleum, oils, and lubricants (POL) waste would be generated from test and construction activities	● Following regulations, SOPs and guidelines, the impact of alternative two would be the same as the proposed action.	● Less impact from hazardous materials and waste	● Vehicles, construction equipment, generators, and fuel storage units would employ a spill containment system (e.g., drip pans) in accordance with the WSMR Spill Prevention Plan. ● CBR simulants and other test materials would be used in the smallest amounts practicable so as to reduce the accumulation of hazardous wastes.
Human Health and Safety, Section 4.10	● Personnel could be exposed to CBR test materials during test preparations, post-test evaluation, and site cleanup. ● Nitrogen gas could displace oxygen producing a hazardous working environment ● Personnel would be exposed to hazards from the use of explosives, heavy equipment operation and post-test evaluations of tunnel targets such as falling rock, cave-ins and dust inhalation	● Same as the preferred alternative plus exposure to test materials that are more toxic	● Less impact to human health and safety	● Personnel will use personal protection equipment (PPE) in accordance with MSDS recommendation for all CBR test materials. ● To avoid hazardous working environments at LB/TS in which nitrogen could displace oxygen all SOPs and safety precautions will be followed to ensure the safety of test personnel. ● Personnel would be trained on safe operation of heavy equipment and wear hardhats and other appropriate PPE. ● Measures to reduce hazards concerning engine exhaust emissions include monitoring for CO, proper ventilation of work areas, and the use of proper PPE.

Table S-1. Summary of Impact Analysis and Proposed Mitigations

Environmental Resources	Impacts of the Proposed Action (Preferred Alternative)	Impacts of Alternative Two	Impacts of the No Action Alternative	Proposed Mitigation
Human Health and Safety, Section 4.10 (Continued)	● Engine exhaust could cause carbon monoxide (CO) poisoning in confined spaces ● Personnel would be exposed to the risk of vehicle collisions with oryx ● Personnel could be exposed to the risk of hantavirus and West Nile virus ● Outdoor working conditions could result in heat-related illness ● Personnel could be exposed to venomous snakes, insects and spiders			● DTRA personnel should be briefed on the potential for oryx/vehicle collisions and precautions to be taken. ● To prevent hantavirus pulmonary syndrome (HPS), exposure to rodents and rodent feces and urine should be avoided. Personnel should avoid areas that have potential hantavirus risk until that risk has been evaluated and abated, if necessary. ● Precautions should be taken to minimize the risk of contracting West Nile virus include avoiding areas with a high concentration of mosquitoes, wearing insect repellent, and draining standing water. ● Personnel should be briefed on desert survival and the signs of heat stroke and heat exhaustion. Personnel should be provided with adequate water and have proper training in first aid for heat related illness. ● Personnel should avoid contact with venomous snakes, spiders, scorpions, and spiny plants.
Socioeconomics and Infrastructure, Section 4.11	● Would provide an added, but relatively small, stimulus to the local and regional economies.	● Same as the proposed action	● No change	● None
Environmental Justice, Section 4.12	● No adverse impacts to minority populations located in the region of influence ● Would not disproportionately affect minority and low-income populations compared to the general population.	● Same as the proposed action	● Same as the proposed action	● None

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TABLE OF CONTENTS

VOLUME II: SUPPORTING APPENDICES

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS and ACRONYMS

ABL	Airborne Laser
ACR	Aerial Cable Range
AFB	Air Force Base
AGM	air-ground guided missile
Alt. SHIST	Alternate Seismic Hardrock In Situ Test
ANFO	ammonium nitrate - fuel oil
APAM	anti-personnel anti-materiel
AQCR	Air Quality Control Region
AR	Army Regulation
ASL	above sea level
ATC	Air Traffic Control
ATCAA	Air Traffic Control Assigned Airspace
ATL	Advanced Tactical Laser
BC	before Christ
BCF	Bioconcentration Factor
BLESTS	Beam Loaded Explosive Simulation Test
BLU	bomb live unit
Bg	*Bacillus subtilis*
Bt	*Bacillus thuringiensis*
C-4	Composition 4
CA	California
CBR	chemical, biological and radiological (simulants)
CEQ	Council on Environmental Quality
CFU	colony-forming units
chem/bio	chemical/biological
CIST	cylindrical insitu tests
CO	carbon monoxide
COIL	chemical oxygen iodine laser
CTS-1	Counter-terrorism Structure #1
CW	chemical weapons
CWC	Chemical Weapons Convention
DES	Directorate of Environmental Safety
DIMP	diisopropyl methyl phosphonate
DMMP	dimethyl methyl phosphate
DPM	dowanol glycol ether
DNA	Defense Nuclear Agency
DoD	Department of Defense
DSWA	Defense Special Weapons Agency
DTRA	Defense Threat Reduction Agency
EA	environmental assessment
EIS	environmental impact statement
EMP	electromagnetic pulse
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FCDSWA	Field Command, Defense Special Weapons Agency
FNSI	finding of no significant impact
GBR	ground based radar
GBU	guided bomb unit

ABBREVIATIONS and ACRONYMS (Continued)

GSA	Government Services Administration
GZ	ground zero
HE	high explosive
HEST	high explosive simulations tests
HPAC	Hazard Prediction and Assessment Capability
HPS	Hantavirus pulmonary syndrome
HMX	cyclotetramethylenetetranitramine
HSR	Human Systems Research
HTD	Hard Target Defeat
IFR	instrument flight rules
ITAM	Integrated Training Area Management
JASSM	Joint Air-to-Surface Standoff Missile
JDAMS	Joint Direct Attack Munitions
LA	Laboratory of Anthropology (University of New Mexico)
LADAR	laser-radar combination
LIDAR	Light Detecting and Ranging
LB/TS	Large Blast/Thermal Simulator
LC_{50}	lethal concentration at which 50% of test subjects die
LCLo	lowest published lethal concentration
LCTA	Land Condition Trend Analysis
LD_{50}	lethal dose at which 50% of test subjects die
LIDAR	light detecting and ranging
LOAEL	Lowest observed adverse effect level
MOA	Military Operation Area
MBRS	Mobile Ballistic Research System
MCL	Maximum Contaminant Level
MeS	methyl salicylate
MOAB	Massive Ordinance Air Blast
MOP	Massive Ordnance (Penetrator)
MSDS	material safety data sheet
MSL	mean sea level
MTR	military training routes
MW	monitoring well
NAAQS	National Ambient Air Quality Standards
NBC	nuclear, biological, and chemical
NECI	Northeast Center Impact area
NEPA	National Environmental Policy Act
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NM	nitromethane (or New Mexico)
NMAQB	New Mexico (NM) Air Quality Bureau
NMDGF	New Mexico Department of Game and Fish
NMED	New Mexico Environment Department
NMNHP	New Mexico Natural Heritage Program
NMSU	New Mexico State University
NO_2	nitrogen dioxide
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service

ABBREVIATIONS and ACRONYMS (Continued)

NTP	National Toxicology Program
NTS	Nevada Test Site
NV	Nevada
O_3	ozone
OEL	Occupational exposure limit
OSD	Office of Secretary of Defense
OSHA	Occupational Safety and Health Administration
PBE	plastic bonded explosives
PEA	programmatic environmental assessment
PEIS	Programmatic environmental impact statement
PETN	pentaerythritol tetranitrate
PHETS	Permanent High Explosive Test Site
PM_{10}	respirable particulate matter
PEL	permissible exposure limit
Pers. Comm.	Personal comunication
PMMA	polymethyl methacrylate
POL	petroleum, oil, and lubricants
PPE	personal protection equipment
PSBA	polystyrene-butylmethacrylate
PSL	Physical Science Laboratory
RDX	cyclotrimethylenetrinitramine
REC	Record of Environmental Consideration
REL	Recommended Exposure Limit
ROI	region of influence
RR	range road
SHIST	Seismic Hardrock In Situ Test
SHPO	State Historic Preservation Office
SO_2	sulfur dioxide
SOC	species of concern
SOI	species of interest
SOP	standard operating procedure
sp	one species
spp	multiple species
SRC	Stallion Range Center
SSA	Socorro Seismic Anomaly
TACMS	Tactical Missile Systems
TCLo	Toxic Concentration Lowest
TDS	total dissolved solids
TECOM	Test and Evaluation Command
TEP	triethyl phosphate
TES	threatened, endangered, sensitive
TNT	trinitrotoluene
TWA	time-weighted average
UAV	Unmanned Aerial Vehicle
UGV	Unmanned Ground Vehicle
U.S.	United States
USC	United States Code
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service

UT	Utah
UXO	unexploded ordnance
VFR	visual flight rules
WIT	Warhead Impact Target
WMD	weapons of mass destruction
WS-ES	White Sands Environmental Services Division
WSMR	White Sands Missile Range
WSPG	White Sands Proving Ground
WSNM	White Sands National Monument

UNITS OF MEASURE

ac	acre
^oC	degrees Celsius
cm	centimeter
dBA	decibel
gm	gram
ha	hectare
kg	kilogram
km	kilometer
kPa	kilopascal
kph	kilometers per hour
KT	kiloton
KVA	kilovolt-ampere
L	liter
m	meter
mg	milligram
Mg	megagram
µl	microliter
µg	microgram
mg/kg	milligram per kilogram
mg/L	milligram per liter
mg/m^2	milligram per square meter
mg/m^3	milligram per cubic meter
ml	milliliter
MW	megawatt
MW/cm^2	megawatt per square centimeter
ppb	parts per billion
ppm/ppb	parts per million per parts per billion
psi	pounds per square inch

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1.0 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

1.1 Introduction

The National Environmental Policy Act (NEPA) of 1969 as amended (42 United States Code [USC] 4321, et seq.), the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations [CFR] 1500-1508), Department of Defense (DoD) Instruction 4715.9, Environmental Planning and Analysis, and specifically, 32 CFR Part 651 [Army Regulation 200-2], Environmental Analysis of Army Actions, which implement these laws and regulations, direct DoD officials to consider environmental consequences when authorizing and approving Federal actions.

The NEPA process (including related regulations) involves environmental impact analysis using a systematic, interdisciplinary approach to potential environmental effects from a proposed action and alternative actions. NEPA analysis is designed to provide full disclosure of the action(s) to the public and to encourage public participation in the decision-making process (see Section 1.6 Public Participation).

This Programmatic Environmental Impact Statement (PEIS) examines the potential for impacts to the environment as a result of the expansion of proposed Defense Threat Reduction Agency (DTRA) construction, operation, and test activities conducted on the White Sands Missile Range (WSMR), NM. DTRA (as lead agency for this action) is seeking to fulfill its mission to counter and defeat threats from weapons of mass destruction (WMD) (i.e., chemical, biological, radiological, and nuclear weapons; and high explosives). WSMR (as cooperating agency through the U.S. Army) manages the environment in which DTRA would conduct its activities. Under this proposed action, additional test facilities, test equipment, infrastructure, and communications links would be constructed and operated for the purpose of providing more realistic testing against various targets including WMD targets. DTRA maintains a number of testing areas and target types at WSMR to support DoD, Federal agencies, and friendly nations' programs to counter proliferation of WMD.

1.2 Background

DTRA was established on October 1, 1998, by the Secretary of Defense under the November 1997 Defense Reform Initiative. The agency was created to safeguard the United States and its allies from WMD. As part of its mission, DTRA evaluates the lethality of chemical, biological, radiological, nuclear and high explosives, and other

advanced weapons. The agency provides a broad spectrum of target types on its test beds (many of them mock-ups of WMD facilities) and directs the development and implementation of new weapons technologies against these targets.

DTRA provides a number of testing areas and target types at White Sands Missile Range (WSMR) for use by various DoD agencies, other U.S. government organizations, companies and allied government experimenters. The Defense Nuclear Agency (DNA), later called the Defense Special Weapons Agency (DSWA) and now DTRA, have operated and maintained testing sites and related infrastructure at WSMR since 1976 (ref. Environmental Assessment of Long-Term High-Explosive Testing at WSMR Permanent High Explosive Test Site, DNA, 1987; Memorandum of Agreement between WSMR and Field Command, Defense Special Weapons Agency, FCDSWA, 1997; Support Agreement between WSMR and Field Command, Defense Special Weapons Agency, FCDSWA, 1998).

Targets and test sites currently operated by DTRA at WSMR include the Large Blast/Thermal Simulator (LB/TS), Permanent High Explosive Test Site (PHETS), Seismic Hardrock In Situ Test Site (SHIST), Alternate SHIST Site (Alt. SHIST), and Hard Target Defeat (HTD) Test Bed (Figure 1-1).

1.3 Purpose and Need

The purpose of the proposed action is to provide adequate test areas and facilities for the evaluation of weapon systems used against simulated enemy ground targets.

There is a need to improve weapon systems designed to defeat enemy military assets, including hardened and reinforced structures. These enemy military assets can house WMD and pose a significant threat to international stability and peaceful coexistence among nations. The military structures and equipment of the United States and its allies, alternately, must also be refined to better withstand attack by enemy weapon systems.

1.4 Scope of the Document

This document analyzes the general characteristics of DTRA testing into the reasonably foreseeable future. DTRA activities that differ significantly from those identified in this PEIS will possibly require separate documentation using the PEIS as a “tier” document. “Tiering” is a means by which environmental analysis under NEPA uses previous documentation as a foundation for subsequent, more specific, actions.

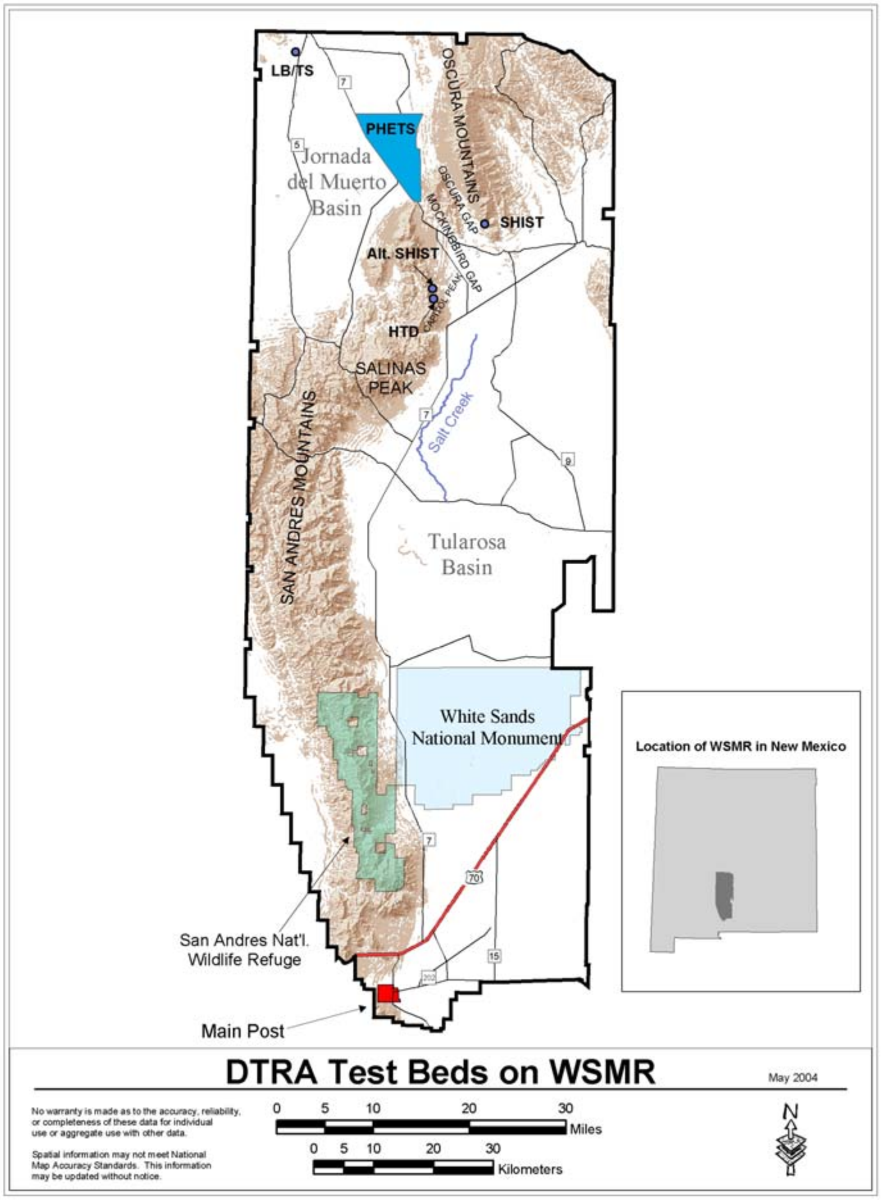

Figure 1-1. Map of WSMR showing DTRA test beds.

Environmental subjects addressed in this document include: physical resources; biological resources; cultural resources; present land use; air space; air quality; noise and blast; radiation; hazardous waste; human health and safety; and socioeconomics and infrastructure. Laws and regulations pertaining to many of these environments are detailed in Appendix A.

1.5 Organization of this PEIS

The purpose and need for the proposed action are discussed in Section 1.0. The alternatives considered in Section 2.0 include alternative one to achieve anticipated testing goals, alternative two addition of simulants with higher toxicity levels, and the no action alternative. Section 3.0, Affected Environments, describes each environment as it presently exists on WSMR; Section 4.0, Environmental Consequences, shows how each environment will be affected by the proposed action and no action alternative. Section 5, Cumulative Impacts, addresses the cumulative effects of the proposed action as well as other past, present, and reasonably foreseeable future actions that have or may be implemented within DTRA's region of influence (ROI).

Analysis in this PEIS emphasizes potential environmental effects on the northern part of WSMR, which is the area most used by DTRA, and is herein defined as DTRA's region-of-influence (ROI) (shaded circle, Figure 1-2) unless otherwise stated in the sections addressing specific resources. The primary DTRA test beds are briefly described below:

Organization of this PEIS

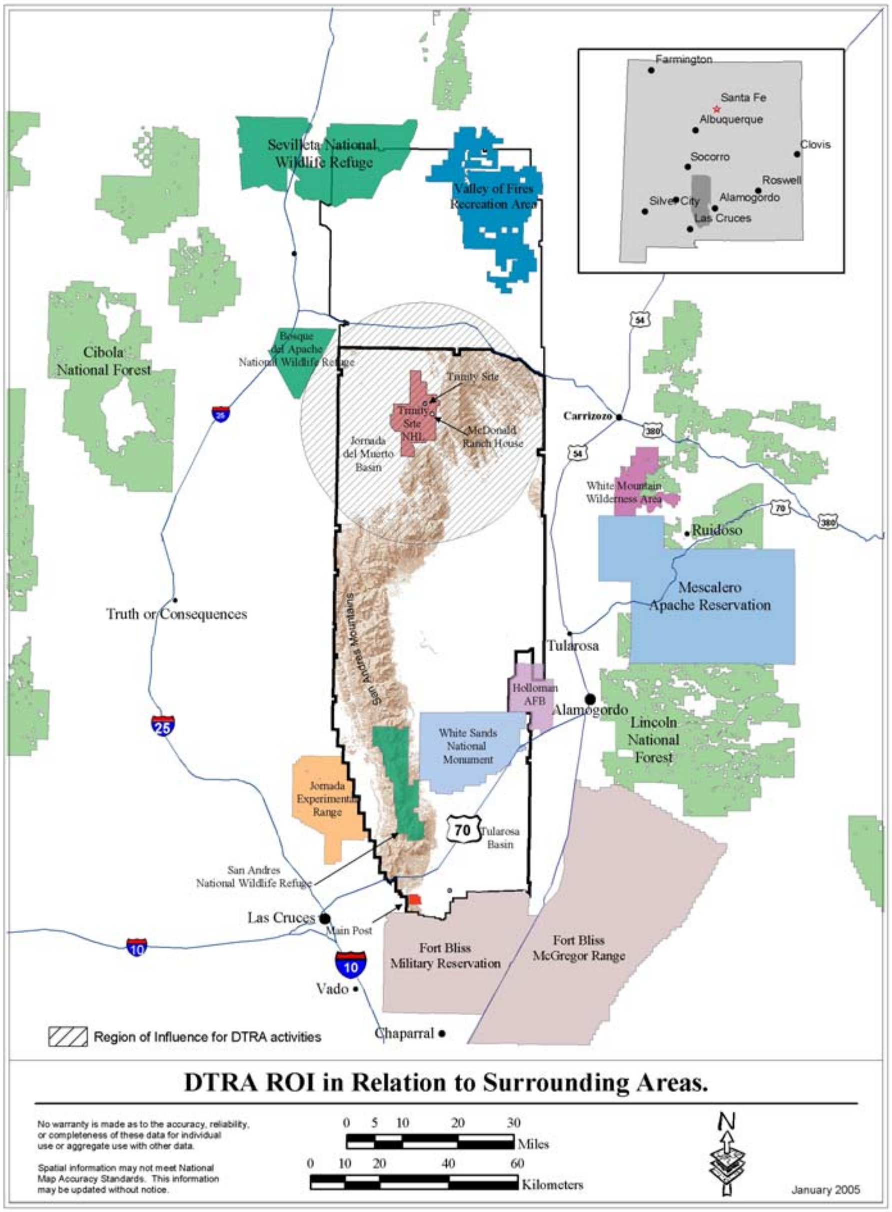

Figure 1-2. DTRA ROI in relation to surrounding areas.

Large Blast/Thermal Simulator (LB/TS) is located near Stallion Range Camp. It is used to evaluate the survivability and vulnerability of full-scale military and other equipment subjected to the blast and thermal conditions of a simulated nuclear explosion. The facility can also be used to simulate conventional explosive blast effects against building facades and military equipment.

- Permanent High Explosive Test Site (PHETS) mostly lies within the boundaries of Trinity National Historic Landmark and is used for high explosive events and tests to evaluate the effectiveness of various weapon systems against hardened targets. Collateral damage resulting from the release of chemical and biological agents after target defeat is also evaluated at PHETS using simulants (non-symptomatic materials which simulate the dispersion characteristics of chemical and biological weapons agents) and taggants (materials used to track the path of simulant plumes through the air).

- Seismic Hardrock In Situ Test Site (SHIST) and Alternate SHIST (Alt. SHIST) are used principally for rock penetration tests using various warhead types. These sites are located on the western slopes of the Oscura Mountains and approximately 2.4 km north of Capitol Peak in the San Andres Mountains, respectively.

- Hard Target Defeat (HTD) Test Bed, which is located in the Capitol Canyon region of the northern San Andres Mountains, was established to provide realistic hardened tunnel targets. These underground structures are excavated and recessed in bedrock and designed to simulate tunnels used to protect personnel and assets, including nuclear, biological, chemical, and conventional weapons, from attack.

DTRA does not propose to test WMD agents in any capacity at WSMR.

1.6 Public Participation

The (CEQ) regulations implementing NEPA require public participation as part of an open process for determining the scope of issues related to the proposed action and its alternatives. Comments and questions received as a result of the DTRA (EIS) process assist the DoD in identifying potential concerns and environmental impacts to the human and natural environment. Comments submitted to DTRA from the public regarding relevant environmental issues will be thoughtfully considered for incorporation into the PEIS. All input from the public will become part of the administrative record.

The scoping phase consists of open discussions with the public and concerned agencies about the EIS scope, proposed action and alternatives to the proposed action, procedural issues, further public involvement, and issues of concern. The DTRA EIS public scoping period began on *May 19, 2003* when the Notice of Intent (NOI) to prepare a PEIS was published in the *Federal Register*. The scoping period ended on *September 15, 2003*.

A Notice of Availability (NOA) for the Draft EIS (DEIS) was announced in the *Federal Register January 28, 2006*. The environmental analysis of proposed actions and alternatives was made available for public review to begin the public comment period. The 60-day public comment period, including public hearings, ended on *March 28, 2006.*

A number of methods were used to inform the public about DTRA activities on WSMR and solicit formal public comment including:

- The NOI and NOA announcements in the *Federal Register*
- Direct mailings to politicians, special interest groups, and landowners in the region
- Paid advertisements in local and regional newspapers in Spanish and English
- News releases to local and regional news media
- Information on the DTRA public website and a WSMR website link to DTRA website
- Public meeting displays where DTRA representatives presented informational material

During the scoping and public comment periods, regulatory agencies and the general public were given opportunities to offer written comments (e.g. letters and emails) and/or oral comments and questions (during public information meetings) regarding the PEIS for DTRA activities on WSMR. All written comments and oral transcripts of public meetings are located in Appendix B. Public scoping and hearing information meetings locations are described in Table 1-1. During the public meetings, attendees were invited to view informational displays, ask questions and/or make comments to the program representatives regarding the draft PEIS.

Table 1-1. PEIS Information Meeting Locations and Dates.

Meeting Type	Meeting Location	Date
Public Scoping	Las Cruces, NM – Holiday Inn	12 August 2003
Public Scoping	Socorro, NM – New Mexico Institute of Mining and Technology	13 August 2003
Public Scoping	Alamogordo, NM – Holiday Inn Express	14 August 2003
Public Hearing	Alamogordo, NM – Civic Center	28 February 2006
Public Hearing	Las Cruces, NM – Ramada Palms	1 March 2006
Public Hearing	Socorro, NM – New Mexico Institute of Mining and Technology	2 March 2006

Comments made during the scoping and public comment periods ranged from strong support of national security goals and DoD activities such as DTRA, to condemnation for promoting violence and war. Many comments 1) largely political in nature, 2) addressing general NEPA and EIS processes, and/or 3) non-related to the DTRA proposed action and alternatives, were considered outside the scope of the PEIS and were therefore not addressed. Public and regulatory agency comments pertaining to specific resources potentially affected by the proposed action were considered for incorporation in the PEIS. These EIS-specific comments are summarized below.

Results of Scoping

This section summarizes the results of the scoping period for the DTRA EIS. The oral and written comments included the following topics:

- **Public Meeting Locations.** In both written and oral comments, individuals had concerns that Albuquerque was not included in the scoping/hearing public meeting locations. Alamogordo, Las Cruces and Socorro were chosen as public information meeting locations based on their proximity to DTRA test beds located on WSMR. These local areas were found to be the nearest to testing activities and therefore the most likely to experience an impact.

- **Proposed Action, Alternatives, and Chemical Simulants**. In both written and oral comments, individuals were supportive of and against the consideration of the No Action Alternative and the use of Alternate Testing Facilities other than WSMR. (Alternatives Considered, including the No Action Alternative (section 2.3) and the Alternatives Considered but Not Carried Forward (section 2.4) are addressed in section 2.0 of the PEIS.) Individuals were also concerned about weapons systems, testing, and chemical simulants used. (Weapons systems and testing are addressed in section 2.1, Description of the Proposed Action. Chemical simulants and impact descriptions are addressed in Appendices E-H.

Impacts of weapons systems and simulant testing are addressed in section 4.0, Environmental and Socioeconomic Consequences.)

- **Flora and Fauna, TES Species, and National Wildlife Refuge.** In both written and oral comments, individuals were concerned about potential impacts to flora and fauna species, particularly TES species, and wildlife habitat as a result of the proposed action. One comment concerned impacts on the national wildlife refuge. One comment concerned cumulative effects on wildlife. (A description of the affected environment and impacts to Flora, Fauna and TES species are addressed in sections 3.2 and 4.2, Biological Resources. A description of the affected environment and impacts to protected areas are addressed in sections 3.4 and 4.4, Present Land Use. Cumulative impacts on wildlife are addressed in section 5.2).

- **Physical Resources (Water and Seismicity).** In both written and oral comments, individuals were concerned about potential surface water and groundwater impacts (including wetlands and floodplains) as a result of the proposed action. Some written comments specifically concerned impacts on seismicity and fractured zones in the Socorro area. (A description of the affected environment and impacts to Water Resources, Geology and Soils, and Seismicity are addressed in sections 3.1 and 4.1, Physical Resources. The western Tularosa basin fault near the DTRA test beds is unrelated to earthquake activity near Socorro, NM. Impacts to Seismicity are addressed in section 4.1.5).

- **Hazardous Materials, Human Health and Safety, and Air Quality**. In both written and oral comments, individuals were concerned about potential impacts resulting from hazardous materials and waste on human health and safety as a result of the proposed action. Some comments specifically concerned testing distances and conditions in relation to human populations, and potential impacts to human health and safety from air quality and water impacts. (A description of the affected environment and impacts to Human Health and Safety are addressed in sections 3.10 and 4.10. Hazardous Materials and Hazardous Waste is addressed in sections 3.9 and 4.9. Chemical simulants and impact descriptions are addressed in Appendices E-H. A description of the affected environment and impacts to Water Resources and Climate are addressed in sections 3.1 and 4.1. A description of the affected environment and impacts to Air Quality are addressed in sections 3.6 and 4.6).

- **Socioeconomics, Environmental Justice and Collateral Effects.** In both written and oral comments, individuals were concerned about potential impacts to employment, economics (including individual, household and regional levels), and other environmental justice and socioeconomic impacts of the proposed action. One comment specifically concerned collateral effects of window damage to residential areas located outside WSMR. (A description of the affected environment and impacts to socioeconomics and employment are addressed in sections 3.11 and 4.11, Socioeconomics and Infrastructure. A description of the affected environment and impacts to minority and low income populations are addressed in sections 3.12 and 4.12, Environmental Justice).

- **Airspace.** In both written and oral comments, individuals were concerned with potential impacts to airspace use including airspace control, unmanned aerial vehicles, air collisions and the potential airspace impact to nearby residential areas. (A description of the affected environment and impacts to Airspace are addressed in sections 3.5 and 4.5. A description of the affected environment and impacts of airspace use on residential areas are addressed in sections 3.12 and 4.12, Environmental Justice).

Results of Public Comment Period

This section summarizes the results of the public comment period and public hearings. The oral and written comments included the following topics:

- **Proposed Action, Alternatives, and Chemical Simulants**. In both written and oral comments, individuals were concerned about weapons systems, testing, and chemical simulants used in the proposed action. One commenter was specifically concerned with potential changes to test sites for other purposes on WSMR. (Future changes to test areas on WSMR is not within the scope of the EIS.) Weapons systems and testing related to DTRA's activities are addressed in section 2.1, Description of the Proposed Action. Chemical simulants and impact descriptions are addressed in Appendices E-H). Impacts of weapons systems and simulant testing are addressed in section 4.0, Environmental and Socioeconomic Consequences. The same commenter expressed concern that her 2003 comments did not appear in the Draft PEIS. (This correction was made and all comments received during these comment periods have been included in the Final PEIS).

- **Hazardous Materials, Human Health and Safety, Water Resources, and Air Quality.** In both written and oral comments, individuals were concerned about

potential impacts resulting from hazardous materials and waste on human health and safety as a result of the proposed action. Other comments specifically addressed surface and ground water resources. (A description of the affected environment and impacts to Human Health and Safety are addressed in sections 3.10 and 4.10. Hazardous Materials and Hazardous Waste is addressed in sections 3.9 and 4.9. Chemical simulants and impact descriptions are addressed in Appendices E-H. A description of the affected environment and impacts to Water Resources and Climate are addressed in sections 3.1 and 4.1. A description of the affected environment and impacts to Air Quality are addressed in sections 3.6 and 4.6).

- **Flora, Fauna and TES Species**. Written comments concerned potential impacts to flora and fauna species, particularly TES species, and wildlife habitat as a result of the proposed action. (A description of the affected environment and impacts to Flora, Fauna and TES species are addressed in sections 3.2 and 4.2, Biological Resources).

- **Physical Resources (Water and Seismicity).** A written comment concerned the potential for chemical simulants seepage into the groundwater triggering seismic activity as a result of DTRA activities. (A description of the affected environment and impacts to Geology and Soils, Water Resources and Seismicity are addressed in sections 3.1 and 4.1, Physical Resources).

- **Airspace and Environmental Justice**. A written comment concerned potential impacts from low-level flights on nearby residential areas. (A description of the affected environment and impacts to Airspace are addressed in sections 3.5 and 4.5. A description of the affected environment and impacts to residential areas, particularly minority and low income populations, are addressed in sections 3.12 and 4.12, Environmental Justice).

1.7 Previous NEPA Documentation

1.7.1 PHETS

The area currently delineated as PHETS was first used in the 1970's for ammonium nitrate-fuel oil (ANFO) explosive tests. Environmental assessments for these ANFO tests were produced for each test series and include DICE THROW, MILL RACE, MINOR SCALE, and MISTY PICTURE. A programmatic environmental assessment was prepared in 1987 for activities conducted at PHETS: *Environmental Assessment of Long-*

Term High Explosive Testing at White Sands Missile Range: Permanent High Explosive Test Site. This document established PHETS as a test site for large scale high explosive testing.

Technological advancements in weapon systems resulted in air-delivered munitions and ground-based projectiles to be tested at PHETS. The NEPA document evaluating this type of testing is *Addendum to the Environmental Assessment of Long Term High Explosive Testing at WSMR PHETS* (July 1995).

Test series involving collateral effects of high explosive weapons were conducted at PHETS. This type of testing involved the use of chemical and biological simulants and taggants (the latter are substances used for airborne plume generation and tracking). Collateral effects and the use of these simulants and taggants were evaluated in *Supplement to the Long-Term High Explosive Testing Environmental Assessment for Collateral Effects Test Series* (October 1995). This type of testing increased to include larger quantities of simulants and additional taggants, specifically the use of triethyl phosphate (TEP). Environmental considerations and concerns were addressed in *Second Supplement to the Long-Term High Explosive Testing Environmental Assessment* (April 1998).

The *Programmatic Environmental Assessment for the Permanent High Explosive Test Site and Bedrock Penetration Test Sites White Sands Missile Range, New Mexico* (March 2002) linked PHETS, SHIST, and Alt. SHIST together to allow more flexibility to the test parameters that were covered in the previous NEPA documents. Environmental effects relating to the four types of tests were examined at the three sites: static explosive tests, warhead penetration tests, collateral damage assessment, and counterterrorism tests. This document is to be used as an environmental reference for future planning and development of anti-terrorism, counterproliferation, and other foreseeable programs.

1.7.2 HTD Test Bed

The Hard Target Defeat Test Bed was approved for construction and limited testing in January 2002 through the document entitled *Environmental Assessment for Hard Target Defeat Testbed, White Sands Missile Range, New Mexico*. This document focused on the construction of four tunnel targets in the Capitol Peak area.

1.7.3 SHIST and Alt. SHIST

The Defense Nuclear Agency and the Defense Special Weapons Agency (DTRA legacy organizations) periodically conducted tests at SHIST and Alt. SHIST in conjunction with testing at PHETS. The *Environmental Assessment for Seismic Hardrock In Situ Test* (SHIST) of 1993 established SHIST as a test site for conducting high explosive tests simulating an underground nuclear blast. Missile impacts at Alt. SHIST began in 1995 and the associated environmental effects were addressed in the NEPA document entitled *Environmental Assessment for Missile Technology Demonstration Program*. Air-delivered inert warheads, the Davis Gun, and air gun tests at Alt. SHIST were analyzed and approved two years later in *Dipole Samson Environmental Assessment* (1997).

SHIST and Alt. SHIST were included in the *Programmatic Environmental Assessment for the Permanent High Explosive Test Site and Bedrock Penetration Test Sites White Sands Missile Range, New Mexico* (March 2002). This document links these sites to PHETS and addresses current testing as well as predicted future testing (refer to section 1.6.1).

1.7.4 LB/TS

The *Environmental Assessment for the Large Blast/ Thermal Simulator (LB/TS) at White Sands Missile Range, New Mexico* (June 1985) evaluates the construction and operation of LB/TS. The operational assessment was based on an estimated 150 blast tests and 56 thermal tests conducted annually.

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2.0 ALTERNATIVES CONSIDERED

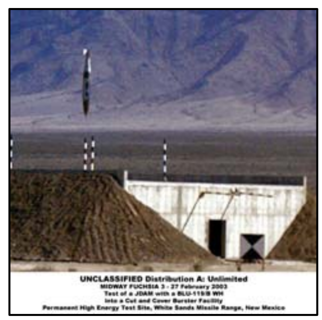
2.1 Description of the Proposed Action (Alternative 1)

The following proposed action is the preferred alternative. This alternative would provide adequate expansion of the scope of DTRA activities into the foreseeable future.

Potential and proposed future testing activities at the various DTRA sponsored test beds and facilities on the White Sands Missile Range (Figure 1-1) are described in the following sections. In all cases, layered tests (those that gather data on multiple systems and have multiple objectives) are encouraged to minimize environmental impacts.

The proposed action includes weapons effects testing, target and weapon lethality testing, and test site improvements. These actions will be explained in the following nine generic categories:

- Collateral effects testing using chemical, biological, and radiological (CBR) simulants
- Hard rock penetration testing
- Hard target lethality and defeat testing
- Advanced weapon lethality testing
- Static high explosive (HE) testing for target lethality
- Large blast/thermal simulator weapons effects testing
- Anti-terrorism tests
- Development of weapons effects targets and test beds
- Improvement to the Permanent High Explosive Test Site (PHETS) Administrative Park



JDDM Missile (Hard Target Defeat Testing, source: J. Fraher, DTRA)

In summary, the nine action categories address the following: the use of new and larger amounts of CBR simulants; continued testing of existing concepts at new sites using existing and new weapon designs; location and use of new sites; and improvement to existing test bed infrastructure.

2.1.1 Collateral Effects Tests Using Simulants

2.1.1.1 Introduction

Simulants have physical and chemical characteristics *similar* to those of weapons materials but are non-hazardous or less hazardous to individuals and to the environment. CBR simulants, taggants (including rare earth materials), and other substances would be used to simulate and track the release of materials into the atmosphere and to support the development of new detection equipment. Dispersal patterns of simulants and taggants would be used to predict the behavior of weapons of mass destruction (WMD) with similar properties. Appendices E, F, G, and H contain information describing environmental fate, exposure, hazard ratings, characteristics, and properties for biological, chemical, and radiological simulants and taggants.

A licensing program was enacted by the U.S. Army Developmental Test Command in which an operation license is required in order to conduct simulant testing at WSMR (U.S. Army, 2002). An approved license would serve as authority to conduct simulant operations and would contain a list all simulants to be used including what form and concentration. The license would outline specific health hazard/toxicity data for each simulant as well as safety requirements. Meteorological conditions would be monitored to predict dispersion patterns. Procedures would be included outlining how personnel with exposure potential to test materials would be controlled. All personnel involved in simulant operations will continue to be adequately trained and training records will continue to be maintained. The license would be renewable on a 24-month basis. Any future simulant operations that deviate from the approved license would require submission and approval of a license amendment to address the changes prior to conducting test operations.

All safety requirements for simulant operations will continue to be strictly followed. Health hazard/toxicity data for each simulant would be included. Procedures would be in place for outdoor dissemination of simulants. They include real time monitoring of meteorological conditions to predict dispersion patterns, final onsite permission, and control of personnel with potential for exposure. Personnel involved in simulant operations would be adequately trained and training records would be maintained.

Biological simulants are biological substances or microorganisms that share at least one physical or biological characteristic of a biological agent, has been shown to be non-pathogenic, and can be used for biological defense testing to replace the agent under study. Typically, biological simulants are common soil bacteria such as *Bacillus subtilus* var. *niger* (Bg) and *Bacillus thuringiensis* (Bt), and killed viruses such as noninfectious influenza A. When released during a test, these simulants are usually tracked indirectly

using a taggant or tracer mixed with the simulant (see discussion later in this section). Appendices E, F, G, and H provide details on physical properties, hazards, and environmental fate for biological simulants proposed for use on DTRA test beds. The type of biological simulants proposed for use are classified by the Centers for Disease Control and Prevention (CDC) as biosafety level 1 which are non hazardous /toxic to humans or fauna.

The Chemical Weapons Convention (CWC), entered into force in 1997, obligates the chemical industry to declare production, consumption, and processing of chemicals that have potential for use in making chemical weapons (U.S. Department of Commerce, 1999, 2002). DoD (and by extension, DTRA) has no documentation or reporting requirements to the Department of Commerce under the CWC. Instead, DoD reports its chemical weapons-related activities to the Office of the Secretary of Defense (OSD) (Ed Garcia, Treaty and Compliance Division, pers. comm., 2004).

Chemical simulants are compounds that have certain properties similar to those of weapon agents such as nerve gas and mustard gas, but they have a reduced physiological effect. Properties of chemical simulants may include dispersion and sensor detection characteristics. During a typical test, chemical simulants are released when a target structure is destroyed and tanks containing the simulant rupture. Air monitoring/sensor equipment is used to detect and measure the concentration of the simulant plume as it drifts through the air away from the test bed. Appendices E, F, G, and H provide details on physical properties, hazards, and environmental fate for chemical simulants proposed for use on DTRA test beds.

Radiological simulants are non-radioactive but contain some of the same chemical elements that can be used in radiological dispersion devices, so-called “dirty bombs”. (The term “dirty bomb” refers to an explosive device that contains radioactive materials intended to cause harm from physical dispersal rather through a nuclear fission reaction). Appendices E, F, G, and H provide details on physical properties, hazards, and environmental fate for radiological simulants proposed for use on DTRA test beds.

Taggants are materials sometimes released with the simulants to help in the tracking of the plume path over substantial distances (approximately 30 km). Taggants selected for use on WSMR (such as diethyl phthalate, diatomaceous earth, yttrium oxide, gold dust, and silica glass beads), are materials not found in nature locally and are generally used only once in a given area to obtain meaningful tracking data. By using taggants in tests, the potential for actual weapons materials to harm the human and natural environments can be predicted without releasing toxic weapons material.

Additional categories of materials that could be potentially released during test events include preservatives, thickeners, anticonglomerates, dyes, and interferents. Preservatives, thickeners, and anticonglomerates are additives to the chemical/biological simulants to improve consistency. Interferents include smoke from the burning of various materials (e.g., plastic, fuels) as part of certain test scenarios to evaluate equipment performance. Appendices E, F, G, and H provide more detailed information on simulants, taggants, and other test materials evaluated under this PEIS.

Mixtures of test materials could be used in future tests and would be evaluated regarding toxicity, possible adverse reaction products, and other characteristics before being considered for use. Prior to testing, any mixtures would be evaluated to ensure tests are within the scope of approved environmental documents.

2.1.1.2 General Description of Collateral Effects Tests at DTRA Test Beds

Tests designed to simulate the release of enemy CBR materials resulting in collateral effects would be conducted at DTRA test beds. The term “collateral effects” refers to the inadvertent harming of non-military personnel or property after the defeat of a WMD target; thus, collateral effects would hopefully be minimized through tests at WSMR using simulant plumes. Higher quantities and an expanded range of test materials than those previously used could be employed in future tests.

Collateral effects also includes impacts of weapon systems on physical property such as military equipment, vehicles, telephone poles, signs, office equipment, etc. During testing, these items are not usually situated on the target directly, but are often placed near the intended impact point to obtain damage and durability information. Vehicles and other equipment used to assess collateral effects are typically drained of fuel and have tires removed, unless otherwise required for certain tests. Collateral effects tests would continue at PHETS (Figure 2-1) and would also be conducted on the other DTRA test beds.

Some test scenarios would be designed to simulate the defeat of enemy chemical and/or biological weapons facilities and the resultant release of an airborne plume. These tests would typically be carried out using hardened targets or thin-skinned targets. Hardened targets include reinforced bunkers (e.g., buried or partially buried concrete-and-earth bunkers); military structures buried deeply beneath the earth; and military structures recessed within granite or other resilient bedrock. Thin-skinned targets simulate legitimate industrial facilities (e.g., pesticide production plants) that could be converted to chemical/biological weapon production facilities. These targets are typically beam-sheet steel structures built on concrete pads.

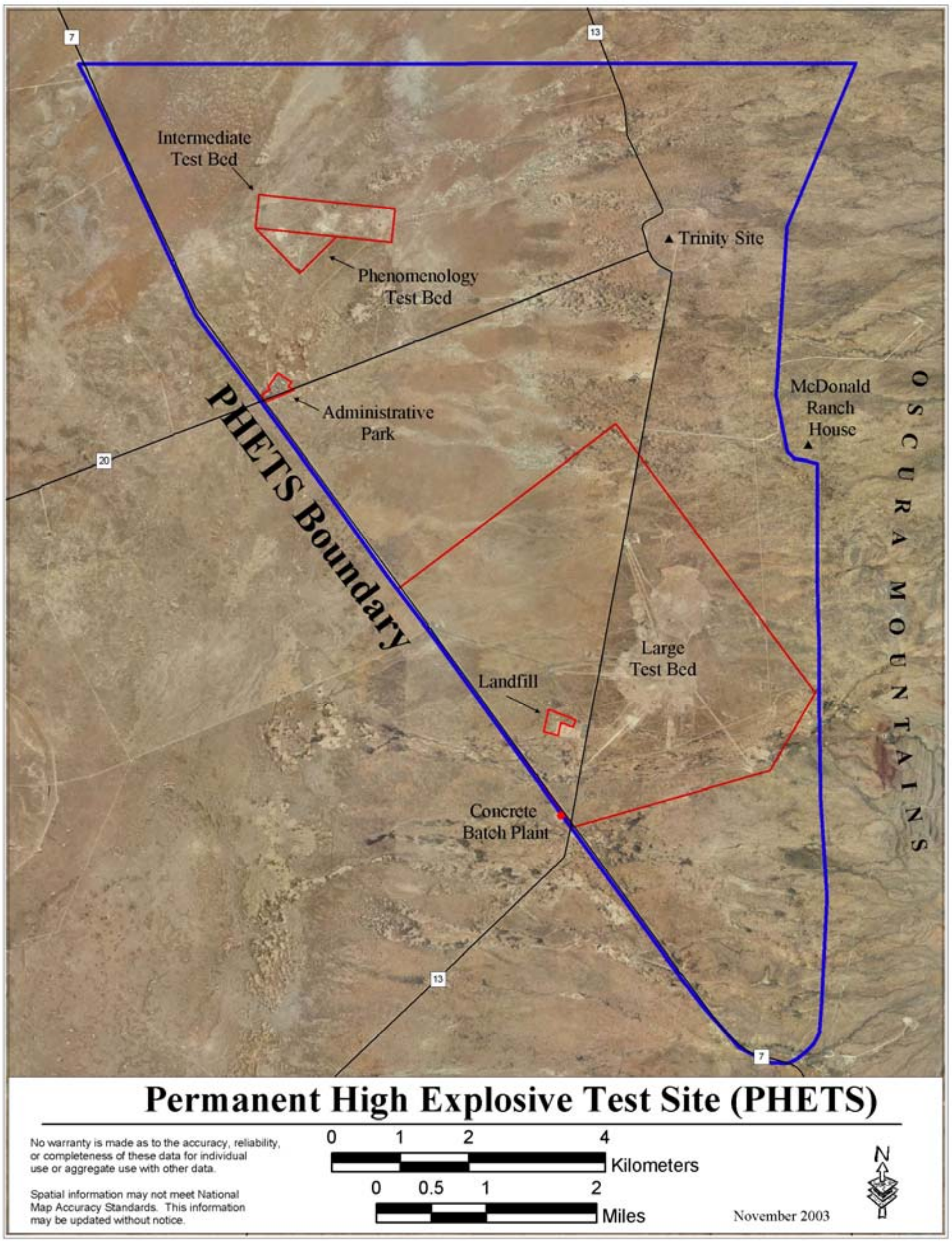


Figure 2-1. Map of PHETS.

Although aircraft-delivered munitions are most commonly used in the previously described tests, anticipated future tests would include weapons deployed against these targets from unmanned aerial vehicles (UAVs) and surface-to-surface weapon systems. UAVs include drones, remotely piloted vehicles, and robotic aircraft (Hunter, Predator, and Global Hawk are examples of currently used UAVs).

Certain tests would use alternative means to disperse the simulant materials and create airborne plumes. “Crop-duster” airplanes and non-explosive air guns would potentially be used to release simulant materials directly over test beds. In some tests, detonations of static charges or air-delivered munitions may be used to release and disperse simulant materials from unconfined containers (i.e., tests not located in a structure). Examples of container types can range from 55-gallon barrels to simulated missiles.

During collateral effects tests, the large majority of simulants and related materials are recovered from containment facilities and a small quantity is destroyed (burned) upon destruction of the targeted test structure. Monitoring of experiments has indicated a relatively small amount of test material is dispersed into the air.

Various instrumentation and photographic equipment would be set up around the test structure or sites. Instrumentation support consists of fielding a wide range of equipment from timing and firing support to more complex test events requiring timimng and firing, and up to 600 measuring instruments. Test data collected by these instrument types include, but are not limited to: pressure, temperature, acceleration, seismicity, and linear displacement. Film and digital cameras, including video cameras, are often arrayed around the test sites to collect photo measurements and to record the events. Camera and video recording can be done in both the visible and invisible (e.g., infrared) portions of the electromagnetic spectrum. Radar and lasers are also used to track and document tests.

Some test events require a local power source including batteries or gas-powered generators ranging from 600W to 5kW. Data, video, and control signals are transmitted via microwave link, trenched cabling, or trenched fiber-optic link. These activities require clearing and grading areas for equipment, placement of portable generators, and deploying electronic cabling across the ground or burying it in trenches.

As part of the proposed collateral effects tests, air samples would be collected at designated locations along the anticipated path of the simulant plume and analyzed for test material concentration. In addition to stationary equipment on the ground, future tests would use air monitoring/sensing equipment mounted in aircraft, UAVs or vehicles. These mobile vehicles are able to fly or drive through plumes and follow the airborne

material over long distances. The collected data would then be used to determine dispersal patterns and monitor changes in concentration of the released test materials over time.

Future collateral effects tests using similar scenarios and simulants would be conducted at several DTRA test beds, including at single and multi-storied test structures. Simulant tests would be conducted at the Hard Target Defeat (HTD) test beds at Capitol Peak using tunnels excavated from bedrock (Section 2.1.3). A proposed test bed for additional tunnel targets in the north part of WSMR has been identified at Mockingbird South (Figure 2-2; see also Section 2.1.8). Small-scale indoor simulant tests are also proposed for the Large Blast/Thermal Simulator (LB/TS) (Section 2.1.6).

Prior to each collateral effects test, a "no go" criteria will be developed to minimize exposure to humans living adjacent to WSMR and to sensitive habitats on the range. The "no go" criteria would be based on several factors including simulant type, computer predictive models, and previous test data regarding plume concentration and weather factors such as wind speed and drift direction. Published data on toxicity to plants and animals, and permissible exposure limits (PEL) for humans, would be used when available to determine safe and acceptable atmospheric concentrations for each simulant. The quantity of simulant released during each test would be limited so that the resulting plume concentration would be many times lower than any reported toxic levels.

The maximum amount of test material allowed per test is listed in Appendices E, G, and H. Up to 16 tests per year would be permitted for each test material. Although most tests are conducted as singular events, a test may also be comprised of as many as eight release events, each being related to the goals of the larger test. In all cases regarding test series, the total annual limit of a given material would not be exceeded. Limits on the amount of simulant released per test would be based upon the type of deployment as follows:

- Up to 4,000 gallons could be released within a test structure
- Up to 1,000 gallons could be released from unconfined containers (not confined within a test structure) by explosive or air-cannon dispersal
- Up to 300 gallons could be released from a "crop-duster" aircraft above a test bed

Simulants inside test structures and dispersed from unconfined containers would use spill containment measures on the ground. Wind direction and velocity would be major considerations regarding tests using unconfined containers and aircraft for deployment to ensure plume movement is toward approved areas within WSMR boundaries.

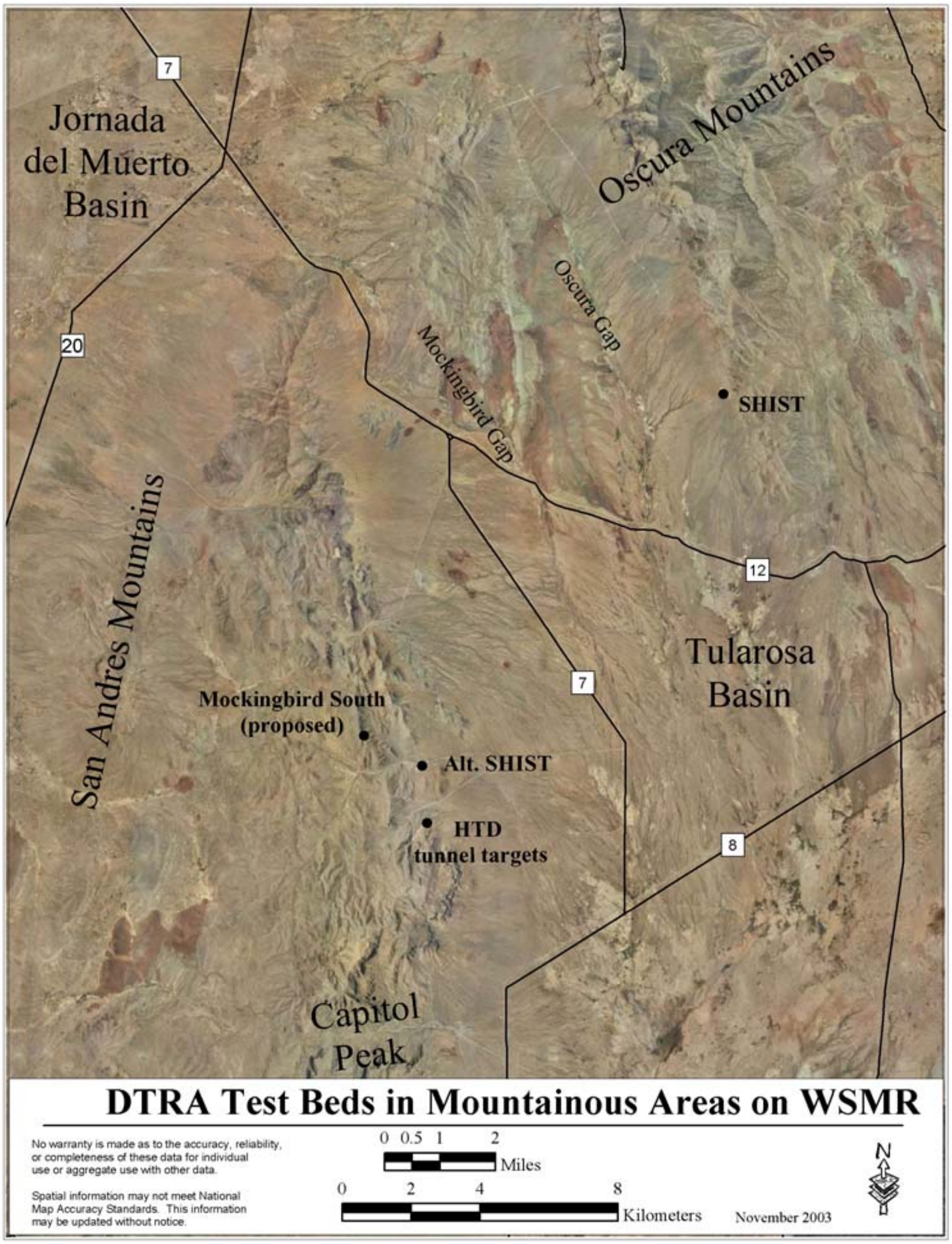


Figure 2-2. Location of SHIST, Alt. SHIST, HTD tunnel targets and proposed Mockingbird South test bed.

Thus, using a test structure example, up to 4,000 gallons of diisopropyl methyl phosphonate (DIMP) can be used in each of 16 tests per a given year for a total of 64,000 gallons; each test could conceivably be further subdivided into eight test events (16 tests x 8 test events per test = 128 test events) as long as the overall amount released for the year is 64,000 gallons or less. Simulant releases at the LB/TS would be limited to amounts not to exceed the effective filtering, containment, and collection capacities of the facility, and to ensure expeditious clean-up within the building.

For ground and airborne sensor calibration prior to a test, small-scale releases of test materials are often required. Sixty (60) small-scale releases (less than approximately 2 kg) would be permitted per year for each test material and would be counted separately from the larger annual allowance for the given test material.

2.1.1.3 Future Collateral Effects Test Materials

Yet unknown test materials not included in this PEIS could be used in future collateral damage tests on DTRA test beds. These additional materials are anticipated to exhibit similar toxicological, physical, chemical, and/or biological characteristics to those analyzed in this PEIS. Prior to testing, any such materials would be evaluated to ensure that they are covered by approved environmental documents or new environmental documentation would be prepared.

2.1.2 Rock Penetration Testing

Rock penetration tests would involve the use of inert full-scale and scale models of penetrator warheads that are fired from specialized guns. Also included in warhead penetration tests are air-delivered and ground-launched live munitions (e.g., missiles and bombs). These tests would be used to evaluate penetration capabilities for various weapons systems into media that include overburden, soil, concrete, bedrock, or a combination of different layered materials.

The ground-based Davis Gun, Sandia Air Gun, and the Mobile Ballistic Research System (MBRS) are examples of devices that may be used to fire inert warheads into the ground. The Davis Gun uses a counterweight and approximately 68 kg of M-30 gun propellant and can launch inert projectiles weighing up to 908 kg. Upon firing, the counterweight is propelled in the opposite direction up to 5.34 km (3.32 mi) (FCDSWA, 1997). Usually, full-scale warheads are used with this system. The Sandia Air Gun uses a mixture of helium and compressed air for propulsion (FCDSWA, 1997). Reduced-scale models are tested with this system. The MBRS is a propellant gun that fires projectiles of up to 50 kg (FCDSWA, 1997).

Ground-based penetrator gun tests using inert warheads have been and would continue to be conducted at PHETS, SHIST, Alt. SHIST, and Mockingbird South. It is anticipated that testing at these sites would remain at a similar level or the level would increase slightly. Additionally, future tests would be conducted at the HTD test bed.

A telemetry system being developed would be fielded on certain penetrator tests. The system consists of a broadcast package and antenna on the penetrator sending RF signals, and a remote receiver antenna and recording equipment. It would require similar ground support to that of other instrumentation previously mentioned in Section 2.1.1.2.

2.1.3 Hard Target Defeat Testing

Hard and deeply buried targets include reinforced bunkers (e.g., buried or partially buried concrete-and-earth bunkers); and military structures located in tunnels or recessed within granite or other resilient bedrock. These structures afford protection to personnel and/or assets from attack. Personnel and assets housed in these structures are nearly invulnerable to direct attack by conventional weapons (U.S. DoD, 1997). Tests would involve the use of inert and/or live penetrator warheads to suppress hardened targets, including tunnel targets excavated from granite and limestone bedrock. HTD tests would also involve explosive tests up to 500 tons TNT equivalency and non-penetrating weapons up to 30,000 lbs TNT equivalency, intended to defeat hard and deeply buried targets by introducing intense overpressure into structural openings. Additional tests would be conducted to defeat targets by delivering boosted and un-boosted weapons through portals and vents directly (e.g., skip bombs). HTD tests may be conducted in conjunction with collateral effects tests (Section 2.1.1) when simulants are used.

Sites at which hardened target defeat tests may take place include the HTD test bed at Capitol Peak (Figure 2-3), PHETS, Alt. SHIST, and SHIST. Most of the weapons used to defeat hardened targets are air-delivered earth-penetrating weapons. A variety of guidance packages and weapons systems are proposed for use during hard target defeat tests. Table 2-1 is a partial list of weapons that are currently tested on DTRA test beds; Table 2-2 is a partial list of weapons anticipated for testing in the foreseeable future. All weapons in the Department of Defense conventional arsenal would be allowed for testing against hardened targets at these sites.

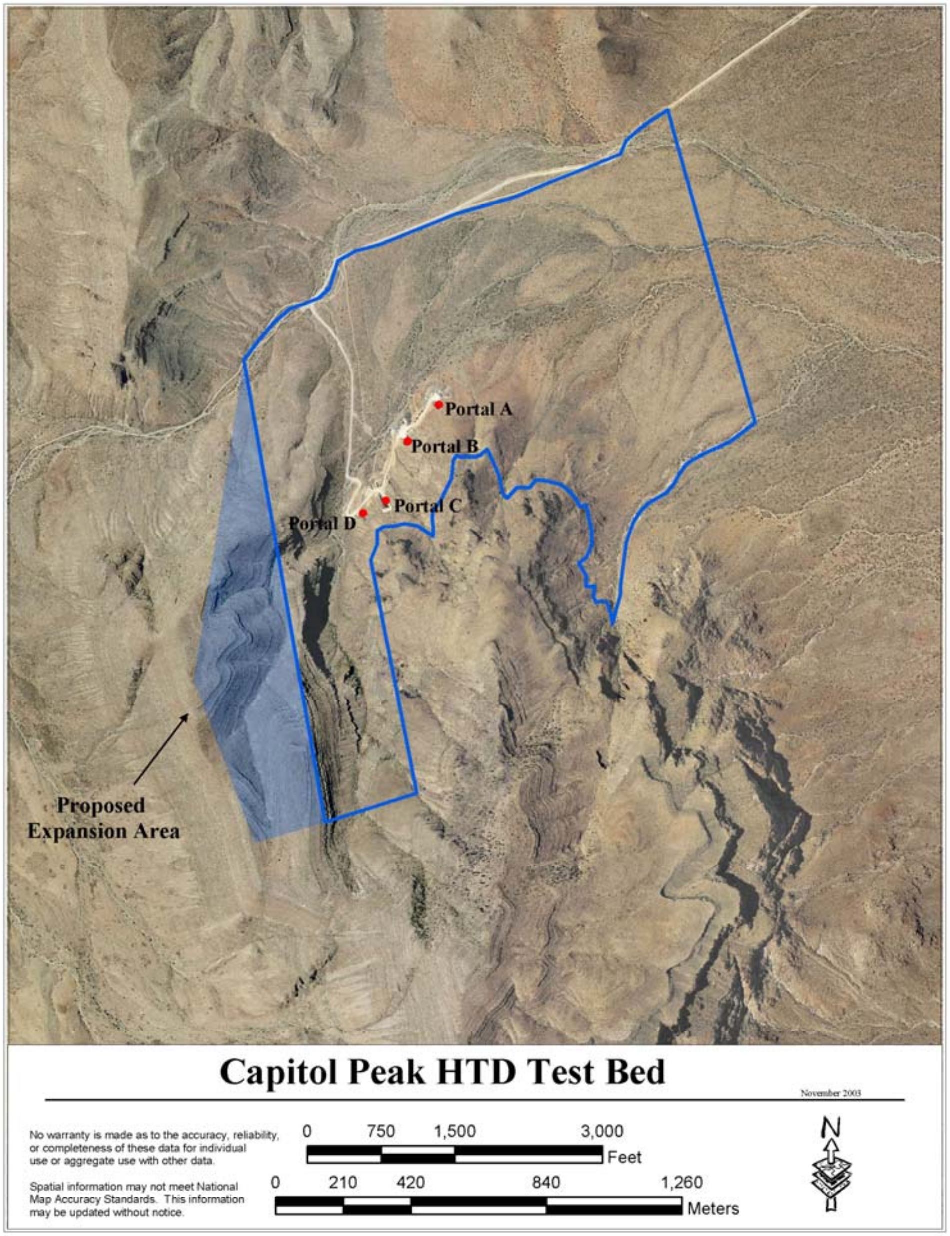


Figure 2-3. Map of HTD Test Bed at Capitol Peak.

Table 2-1. Examples of Current Weapons and Delivery Systems Used on DTRA Test Beds.

Weapon System	Live/Inert (* Inert may be substituted for live depending upon test requirements)	Comments
TACMS-P	Live	Surface-to-surface missile
JASSM	Live	Air-delivered cruise missile
Tomahawk	Live	Ground-launched cruise missile
BLU-91	Live*	Air-delivered bomb
BLU-92	Live*	Air-delivered bomb
BLU 109	Live	Static Detonation
	Inert	Air-delivered bomb. Guidance package depends on aircraft availability
	Live	Air-delivered bomb. Guidance package depends on aircraft availability
	Live/Live	Optimum Dual Delivery. Guidance package depends on aircraft availability
	Inert	
	Live	Fill previously dropped inert weapon with explosive (QM100RAT) and detonate in situ
BLU 113	Inert, Live	Air-delivered bomb
	Live/Inert or Live/Live	Optimum Dual Delivery
BLU 121	Live	Thermobaric mixture produces high temperature effects
MK 82	Live*	
MK 83	Live*	
MK 84 General Purpose Bomb	Live	Static Detonation
	Inert	Guidance package depends on aircraft availability
	Live	Guidance package depends on aircraft availability
Thermobaric Munitions	Live/Static	Explosive mixture that produces high temperature effects.

Table 2-2. Examples of Future Weapons and Delivery Systems Planned For Testing on DTRA Test Beds.

Weapon System	Live/Inert (* Inert may be substituted for live depending upon test requirements	Comments
Intermediate Range Ballistic Missile (IRBM)	Live/Inert	
Advanced cruise missiles	Live/Inert	
Small diameter bomb	Live	
BLU-116 Follow-on	Live*	

Table 2-2. (Continued).

Weapon System	Live/Inert (* Inert may be substituted for live depending upon test requirements	Comments
MTD-3B	Inert	Kinetic penetrator warhead test planned for 2006
Massive Ordnance (Penetrator) MO(P)	Live	
Shallow Earth Penetrator	Inert	Penetration of weapon case only

The types of explosives that are commonly used in the warheads include Tritonal explosives, Plastic Bonded Explosives (PBX), and H-6 (Table 2-3). Tritonal explosives consist of 20% aluminum in Trinitrotoluene (TNT). PBXN-109 is a plastic bonded explosive charge containing insensitive RDX, which allows for transportation and handling with less chance of accidental detonation while retaining other characteristics of the composition. PBXIH-135 contains HMX, polyurethane rubber, and aluminum powder. The aluminum powder allows the mixture to burn for longer and at a higher temperature while utilizing available oxygen to continue the reaction. PBXIH-135 is termed a "thermobaric" explosive, which belongs to a class of fuel-rich compositions that release energy over a longer period of time than standard explosives, thereby creating a long-duration pressure pulse when detonated in confined spaces. H-6 is a binary explosive that is a castable mixture of RDX, TNT, powdered aluminum, and D-2 wax with calcium chloride added. This is the standard bursting charge for general-purpose bombs.

Target structures would eventually be retired from testing at a point when renovation is no longer practical or possible. DTRA would decide when to cease testing and develop a closure plan, in consultation with WSMR, for disposition of obsolete targets. Options for buried concrete bunker and tunnel targets could include in place demolition and burial, with additional earth material brought in to re-establish the approximate original contours of the area. At the request of White Sands Environment and Safety Directorate (WS-ES), restoration of the target site may include re-seeding with native plants or other environmental mitigations.

Depending on the closure plan, aboveground structures would be demolished and resulting debris would be deposited in the construction and demolition landfill at PHETS. Alternatively, a closure plan could call for the target site being sealed and abandoned, with no further measures required.

Table 2-3. Ideal Explosives, Warhead Explosives, and Bulk High Explosives Commonly Used on WSMR.

Ideal Explosives[1]	Composition
C-4	Composition 4
RDX[2]	Cyclotrimethylenetrinitramine
HMX[3]	Cyclotetramethylenetetranitramine
TNT	Oxygen Poor, Trinitrotoluene
Pentolite	50/50 mixture of PETN (pentaerythritol tetranitrate) and TNT
Warhead Explosives	
Tritonal	TNT, aluminum
PBX[4]	RDX, HMX, aluminum
H-6	RDX, TNT, aluminum
AFX 777, AFX 757, PBXIH-136, PBXN-111	AP[5] + Al[6] +RDX/HMX
Bulk High Explosives	
ANFO	Ammonium Nitrate-Fuel Oil
ANFO Slurry	Slurry of ANFO
QM-100 (R, A, T)	Emulsion with aluminum powder
Iregel-82	Emulsion explosive

[1] This term refers to a class of explosive in which the oxidizer and fuel are components of the same molecule and thus create a more efficient chemical reaction upon detonation.
[2] RDX stands for Royal Demolition explosive. It is also known as cyclonite or hexogen. The chemical name for RDX is 1,3,5-trinitro-1,3,5-triazine. It is a white powder and is very explosive. [Source: http://www.atsdr.cdc.gov/tfacts78.html as of August 28, 2003.]
[3] HMX is an acronym for High Melting explosive. It is also known as octogen and cyclotetramethylene-tetranitramine, as well as by other names. [Source: http://www.atsdr.cdc.gov/tfacts98.html as of August 28, 2003.]
[4] PBX is a term applied to a variety of explosive mixtures, which have high mechanical strength, good explosive properties, excellent chemical stability, relative insensitivity to handling and shock, and high thermal output sensitivity. [Source: http://www.islandgroup.com/ExplosiveChemistry.html as of September 8, 2003.]
[5]AP is an acronym for Aluminum perchlorate
[6]Al is an acronym for Aluminum

2.1.4 Advanced Weapon Systems

Weapons using advanced technologies that are presently in various research and development (R&D) stages, may be tested on DTRA test beds in the future and are discussed in the following section. The weapons described below are included as examples of systems that would possibly be tested in the near future. However, it is likely that other systems would be developed which are presently unknown but would also complement the stated mission of DTRA.

UAVs (such as Predator) would continue to be developed for reconnaissance roles and as sensor platforms. Also, these vehicles would continue to evolve as weapon platforms and as actual weapons.

Ground and airborne lasers have been used for guidance and tracking of weapon systems at WSMR (and DTRA test beds) for many years. Most commonly, a ground target is illuminated with a laser and an air-delivered munition “fixes” upon the target during its

flight and ultimate impact. Surface-to-surface weapons can also be guided to their targets using lasers.

Future testing at DTRA test beds may also include the use of lasers as weapons. In addition to lasers now being developed to intercept and destroy missiles in flight, the DoD is developing compact, high-powered lasers that may likely be used in the future to defeat military targets on the ground. These futuristic weapons may be mounted on conventional aircraft, UAVs, and ground vehicles.

Unmanned ground vehicles (UGVs) are planned for use in nuclear, biological, and chemical (NBC) battlefields as sensor platforms to detect the presence of harmful materials. Most UGVs are relatively small hybrid electric vehicles with four wheels that can be remotely controlled or pre-programmed for certain tasks. A possible future military role for UGVs may be for use as actual weapons containing explosive charges, in which the explosive carrying UGV would be deployed from aircraft to defeat specific targets on the ground.

Electromagnetic pulse (EMP) weapons are designed to disable electronic systems (particularly computers and communications equipment). EMP weapons testing may be conducted at PHETS and HTD test beds where mock command-and-control facilities could be constructed to analyze the effectiveness of such weapons against enemy targets. Alternatively, U.S. and allied electronics may be tested for their ability to withstand an EMP attack.

Munitions with alternative payloads to conventional high explosives may be tested on DTRA test beds to defeat hardened targets. These non-energetic weapons would deploy various chemicals, abrasives, foams, and similar substances to physically or chemically disable equipment, or make the attacked facility uninhabitable, without necessarily causing lethal effects. Early tests would likely involve release of static payloads inside bunker or tunnel structures to analyze the effectiveness of various non-energetics; later testing would include air-delivered payloads. Non-energetic tests would affect small (mainly enclosed) areas and would not violate any existing weapons treaties or conventions.

Advanced energetics testing is done to enhance the explosive power of weapons. Aluminum is the element most commonly added to explosive mixtures to create the desired effect. In the future, a wider variety of metals and alloys may be tested (e.g., magnesium, titanium, zirconium, iron, lithium, boron, nickel, copper, tungsten, and molybdenum).

Additional types of possible future testing may also include: WMD agent defeat testing; smart bomblet testing (munitions that can detect when target is sufficiently close to detonate); and testing of conventional and penetrator bombs designed for timed detonation against multiple tunnels (or vents).

2.1.5 Static High Explosive Tests

In recent years, static HE tests have been conducted whereby explosives are attached in or near a test structure to assess survivability and damage characteristics. A test structure is typically a reinforced bunker specially built for the test, and the explosive may be above or below ground. A remote timing and firing system hard-wired to the charge detonates the explosive. In the future, non-hard-wired systems could be used.

The Comprehensive Nuclear Test Ban Treaty (CTBT), signed but not ratified by the U.S. bans nuclear explosions from weapons testing or peaceful purposes. A provision of the CTBT also calls for the establishment of an International Monitoring System (IMS) to detect nuclear explosions. Large-scale chemical explosions, such DTRA static HE tests, are allowed for certain purposes including calibration of detection equipment. Chemical explosions greater than 300 tons TNT equivalent must be reported with information on the blast (for example, location, time, and type of explosive).

Future static HE tests at DTRA test beds addressed by this PEIS would be consistent with earlier tests in terms of explosive materials used, magnitude and frequency (U.S. Army, 2002b). The magnitude or frequency of static tests is not predicted to increase.

The DTRA test beds (PHETS, SHIST, Alt. SHIST, HTD, LB/TS, and Mockingbird South) would be used for static high explosive (HE) tests, with PHETS being the primary test bed for this category. Static testing includes high explosive detonations from a source statically placed on a test bed (i.e., these tests do not include a means of delivery). PHETS was created primarily to provide a location for conducting HE tests consisting of igniting above and belowground static (stationary) charges. Three test beds are delineated at PHETS: large, intermediate, and phenomenology (Figure 2-1). The use of these different test beds is based primarily on explosive magnitude.

The largest static HE tests were conducted at PHETS mostly in the 1970s-1980s to evaluate the survivability of military assets against simulated nuclear blasts. A further aim of these tests was to calibrate equipment used to verify compliance with the Threshold Test Ban Treaty signed in 1974 to limit the magnitude of underground nuclear testing to less than 150 kilotons (KTs). These large-scale tests used many tons of ANFO

ammonium nitrate-fuel oil (ANFO) per event. Other explosives used in tests since the inception of the large test bed included nitromethane, TNT, and QM-100RA. Aluminum powder mixed with liquid oxygen was used in large HE tests as a high-temperature incendiary. Table 2-3 lists the approved bulk HE most commonly used on WSMR.

Static HE tests at the Capitol Peak HTD test bed and Mockingbird South would consist of charges placed inside tunnel targets. Smaller tests would be conducted to obtain explosive characteristics and phenomenology data (phenomenology is the analysis of individual components separate from a larger system). Examples of test programs are: Cylindrical InSitu Tests (CIST), High Explosive Simulation Tests (HEST), and Beam Loaded Explosive Simulation Tests (BLEST). The purpose of these tests would be to simulate and collect data on nuclear air blast and ground shock stress boundaries.

2.1.6 Large Blast/ Thermal Simulator Testing

The Large Blast/Thermal Simulator (LB/TS) is a DTRA-operated test facility that began operation in October 1995. It was originally constructed to simulate the blast and thermal conditions of a nuclear explosion in an environmentally safe manner. The capability of the simulator was expanded in the last few years to support anti-terrorism missions. The facility is capable of handling 20 nuclear simulation tests and at least 20 anti-terrorism tests annually. The proposed action would include continuing these test activities.

The LB/TS is located on 50 acres in the northwest corner of WSMR, and is the largest blast and thermal simulator in the world. Full-scale military systems such as armored vehicles, missile launchers, communication shelters, radomes, and aircraft can be tested within the facility. Systems can be tested using thermal or blast conditions, or a combination of both.

The blast simulation is produced by the rapid, well-timed release of heated, pressurized nitrogen gas into the 175-meter long, 20-meter diameter expansion tunnel. The resulting blast environment strikes the test object with a planar shock wave. Eight thermal jets located just before the target section of the LB/TS produce the thermal simulation. By using the thermal simulation, a target is exposed to extreme radiant heat before the shock wave arrives, simulating the heat generated by a fireball from a detonated nuclear weapon. The simulator's integrated data acquisition system measures and digitally records over 200 channels of environment and target reaction data. These data are used to evaluate a system for survivability and vulnerability from a nuclear detonation.

The LB/TS has recently developed a new capability to conduct anti-terrorism testing. High explosive detonation cord is used to test the survivability of material used for the outside walls and windows of buildings (the curtain wall) against simulated terrorist threats. Small-scale testing is an important component of the anti-terrorism research being done at LB/TS. Small-scale testing includes experiments such as measuring the breakage resistance of various compositions and structures of sheet glass exposed to simulated terrorist attacks.

Small-scale indoor simulant testing is proposed for the LB/TS. Small quantities (approximately 45 kg [100 lbs.] per test) of CBR simulant materials would be released in the facility, alone or in conjunction with other testing. Simulant releases at the LB/TS would be limited to amounts not to exceed the effective filtering, containment, and collection capacities of the facility, and to ensure expeditious clean-up within the building.

2.1.7 Anti-Terrorism Tests

Anti-terrorism tests would be conducted mainly at PHETS on the Intermediate Test Bed and would sometimes involve using the Component Test Structure 1 (CTS-1) (Figure 2-1). CTS-1 is a four-story mock-up of a typical Government Services Administration (GSA) office building. These tests would be designed to examine the survivability of personnel and property against a terrorist attack, mainly using explosives. Tests conducted to date on CTS-1 have involved relatively small amounts of explosives, with the greatest magnitude being 2,270 kg (5,010 lbs) of C-4. Prior to each test, the structure would be re-fitted to the required specifications regarding wall paneling, glass, etc. After a number of test events, major renovations would have to be done to restore the structure for future tests. Ultimately, CTS-1 would be retired when the structure is no longer sound or repairable, and new single and multi-story structures would then be built at PHETS, or other DTRA test beds, as required. In addition to the CTS-1 test activities, several experiments have been fielded using large amounts (about 10 tons) of explosives loaded in typical terrorist vehicles (tankers, rented panel trucks, etc.).

Other types of anti-terrorism tests could include breaching of structures or equipment by mechanical or explosive methods. Personnel involved with the breaching activities could be exposed to small quantities of chemicals released prior to or during the actual breaching operation.

2.1.8 Expansion of DTRA Test Beds

Additional granite and limestone test beds would be required to support future DTRA activities on WSMR. Usable bedrock at SHIST and Alt. SHIST sites is diminishing, and it is reasonably foreseeable that additional bedrock outcrops would be needed for rock penetration tests (Section 2.1.2) and HTD tests (Section 2.1.3). Additional bedrock adjacent to existing DTRA sites would also be required for tests on explosive equivalency of various charges and charge configurations fully coupled to rock, which is a type of static high explosive test (Section 2.1.5).

SHIST site would also be expanded toward the northeast into more granite exposed along a steep hillside (Figure 2-4). Additional granite, suitable as testing media, is present on the eastern flanks of Capitol Peak adjacent to the existing tunnel targets (Figure 2-2). Boundaries of the two test beds would be expanded to encompass more of this undisturbed bedrock.

Limestone outcrops, with potential as test beds, have been identified on the relatively flat terrain west of Alt. SHIST site (Figure 2-5) and on the ridge bounding the western part of the Capitol Peak HTD test beds (Figure 2-3). Alt. SHIST and Capitol Peak HTD test beds would be extended into these limestone terrains to accommodate tests requiring this rock type. Up to six additional tunnel targets are planned in the Capitol Peak HTD test bed area.

Up to three tunnel targets are planned in an area termed Mockingbird South (Figure 2-2). This test bed would be in granite terrain on a sloping hillside covering approximately 66 hectare (ha) [162 acre (ac)]. Existing roads would be improved if required. Mockingbird South was surveyed for biological and archaeological resources during preparation of the HTD EA. No threatened, endangered, or sensitive (TES) species or National Register eligible cultural resources were identified (U.S. Army, 2002a).

New target facilities would be built on various test beds to replace existing unusable targets or to represent new target configurations. New target configurations could be single and/or multi-story structures.

2.1.9 Improvements to the PHETS Administrative Park

Most of the PHETS area is within view of the Trinity National Historic Landmark, where construction of new (post-World War II) permanent structures is not allowed. This stipulation is based upon agreement between WSMR and the State Historic Preservation Office (SHPO). Thus, the existing PHETS Administrative Park was built using trailers or

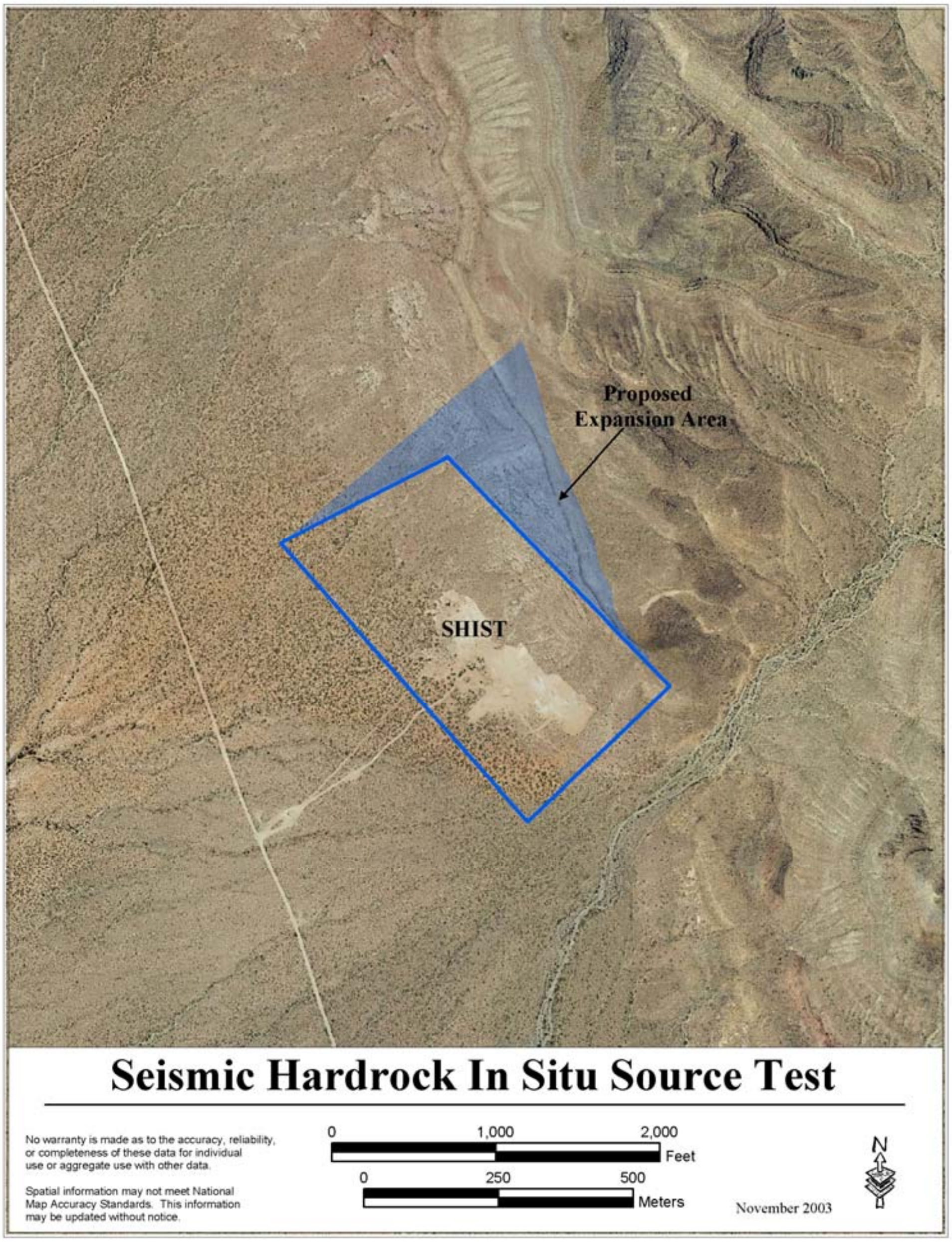


Figure 2-4. Seismic Hardrock In Situ Test Site (SHIST).

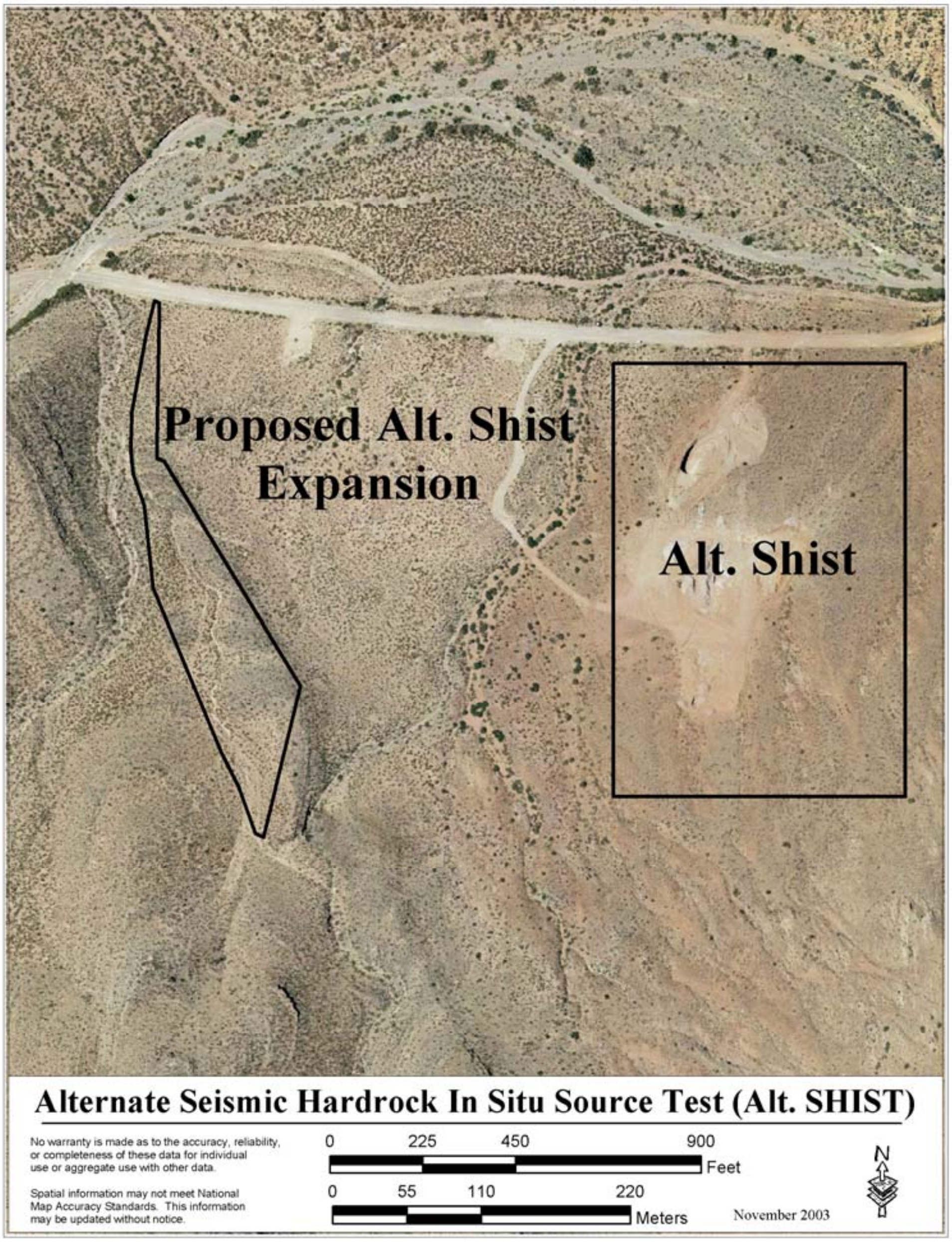


Figure 2-5. Alternative Seismic Hardrock In Situ Test Site (Alt. SHIST).

other non-permanent facilities. A five-year plan for improvements to the PHETS Administrative Park was initiated under earlier environmental documentation (U.S. Army, 2002b) and further actions would be covered in the PEIS.

DTRA proposes to upgrade the PHETS Administrative Park by replacing the trailers/temporary structures with energy efficient pre-engineered buildings placed on concrete slabs. Some of the planned improvements include upgrading the existing test control building and lab with restroom facilities. The current water storage tank, water distribution system, and septic system would be expanded to allow plumbing to the new buildings. DTRA or their designated contractor(s) would acquire all necessary permits prior to construction or modification of these facilities. These actions would occur within the existing PHETS Administrative Park activity area and would not require additional land. These pre-engineered buildings and concrete slabs are temporary structures that would be dismantled and removed when no longer needed.

2.2 Addition of Simulants Having Higher Toxicity Levels (Alternative Two)

This alternative contains all the actions described in the alternative one plus the addition of chemical simulants and taggants/tracers that are considered to have higher toxicity levels than those considered under alternative one. Chemical simulants added to the second alternative include diisopropyl fluorophosphate (DFP), 2-chloroethyl ethyl sulfide (CEES), diethyl methyl phosphonate (DEMP), diisopropyl methyl phosphonate (DIMP), and bis (2-ethylhexyl) phosphate (DEPHA). Tracers and taggants added to the second alternative include lead (II) selenide, lead (II) telluride, mercuric sulfide red, Mercury (II) selenide, and Mercury (II) telluride (Table 2-4).

Alternative two would provide a broader selection of chemical simulants that would be available for collateral effects testing. However, the addition of these test materials would pose a greater hazard to human health and the surrounding environment than those proposed under alternative one. Test personnel would be exposed to chemical simulants having higher toxic properties and some of these simulants can cause severe injury or even death at small doses. The increased hazard of these chemicals, lead to identifying alternative one as the preferred alternative.

Table 2-4. Additional Simulants Considered Under Alternative Two

Chemical Simulants	Tracers and Taggants
Bis (2-ethylhexyl) phosphate (DEPHA)	Lead (II) Selenide
2-Chloroethyl ethyl sulfide (CEES)	Lead (II) Telluride
Diethyl methyl phosphonate (DEMP)	Mercuric Sulfide Red
Diisopropyl fluoro phosphate (DFP)	Mercury (II) Selenide
Diisopropyl methyl phosphonate (DIMP)	Mercury (II) Telluride

2.3 No Action Alternative

The no action alternative would effectively cap the magnitude and extent of DTRA activities at the current level on WSMR. The no action alternative would result in less overall impact to the environment when compared to alternatives one and two. This alternative, however, would be a detriment to national security interests concerning the development of threat reduction technologies including new weapons of mass destruction (WMD) defeat capabilities. The no action alternative would also result in the continued testing under the current existing National Environmental Policy Act (NEPA) documentation on WSMR, which would expire over time as their analyses become outdated. The anticipated magnitude and extent of future DTRA testing activities would not be adequately addressed.

2.4 Alternatives Considered but not Carried Forward

2.4.1 Alternate Testing Facilities

Facilities other than WSMR may be used for conducting the testing activities presented in the proposed action. However, no single facility, other than WSMR, has been identified that could provide testing sites and support for all types of testing presented in the proposed action. Static testing conducted at PHETS, SHIST, Alt. SHIST, and Capitol Peak HTD test beds could be conducted at China Lake, California or Nevada Test Site, Nevada. However, aerial delivery options available at WSMR would be insufficient at China Lake and Nevada Test Site. Nuclear effects testing in an indoor, controlled setting require a special facility that has been constructed at WSMR (i.e., LB/TS). Regardless of whether another facility could accommodate all of the DTRA activities, much effort and capital has been invested at WSMR to create the high-quality testing environments required by DTRA and its customers. Additionally, there is a substantial amount of historical data from previous tests that is valuable for current and future testing programs.

Other locations for DTRA tests were considered in a previous environmental assessment, and WSMR was preferred due to its comprehensive capabilities (U.S. Army 2002b). The scope of DTRA test activities still remains broad, and consideration of other test facilities would not be viable. Conducting the activities at a single testing facility such as WSMR, allows a given test customer to consolidate and analyze information more efficiently. Additionally, the expense of testing would be reduced as resources could be more easily shared between testing sites, if necessary. The use of alternative testing facilities is not carried forward for further analysis.

2.4.2 Sole Use of Computer Modeling and Simulation

Computer modeling and simulation, in regard to collateral effects testing, is an important tool for predicting the fate and transport of chemical and biological weapons materials. If computer modeling and simulation were the sole means of gathering data, essentially no environmental impact would take place on WSMR. However, real data acquired in field-testing scenarios is necessary to refine the models and validate model predictions. Computer modeling and simulation without actual test data is insufficient. This alternative, as a substitute for activities described in the proposed action, is not carried forward for further analysis.

3.0 AFFECTED ENVIRONMENT

3.1 Physical Resources

3.1.1 Location Description and Topography

White Sands Missile Range (WSMR) is located in south-central New Mexico and lies within the Mexican Highland section of the Basin and Range Physiographic Province (Hawley, 1986). This region is typified by alternating north-south aligned mountain ranges separated by expanses of sediment-filled basins (Peterson, 1981; Hawley, 1986). Consistent with the regional basin and range topography, the overall landscape of WSMR consists of two large basins, the Jornada del Muerto and the Tularosa, which are separated mainly by the San Andres Mountains (Figure 3-1).

The Jornada del Muerto Basin consists of a broad plain at the surface, bounded on the east by the Oscura, San Andres, and Organ mountains, and on the west by the Fra Cristobal and Sierra Caballo ranges (not on WSMR). The basin measures approximately 193 km (120 mi) long and from approximately 24 to 48 km (15 to 30 mi) wide. The Jornada del Muerto is a closed basin (water does not drain out of the basin), and elevation ranges from approximately 1,433 to 1,554 m (4,700 to 5,100 ft) above mean sea level (MSL). The surface of the Jornada del Muerto has a higher elevation than the Tularosa Basin as a result of thick sequences of alluvial fans (sediments deposited by running water) that extend westward from the San Andres Mountains. The Permanent High Explosive Test Site (PHETS) and the Large Blast/Thermal Simulator (LB/TS) are located in the Jornada del Muerto Basin (Figure 3-2).

DTRA test beds lie within the alluvial plain of the Jornada del Muerto Basin, northern portions of the San Andres Mountains, and an area on the western side of the Oscura mountains.

PHETS lies on a nearly level alluvial plain in the northern Jornada del Muerto Basin. It is located in Socorro County approximately 21 km (13 mi) south of Stallion Range Center in the northwest corner of WSMR. PHETS is the largest of the DTRA test sites and has an overall area of approximately 9,068 hectare (ha) [22,400 acre (ac)]; however, most test activities at PHETS take place in three test beds that cover a smaller area of approximately 2,123 ha (5,246 ac). The overall topography at PHETS is nearly level with a very gentle westward slope. The topography at PHETS was modified to accommodate the numerous buildings, target bunkers, parking lots, road networks, a

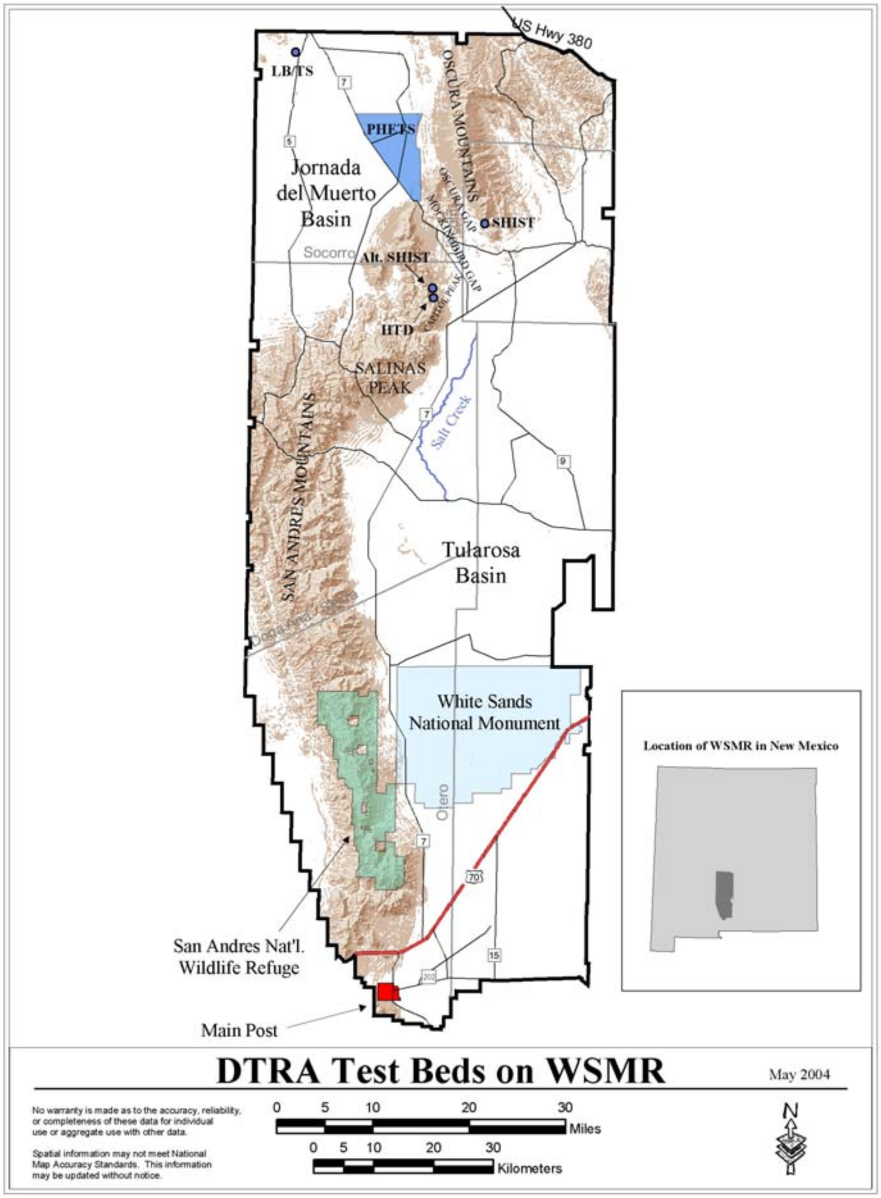


Figure 3-1. Map of WSMR showing DTRA test beds.

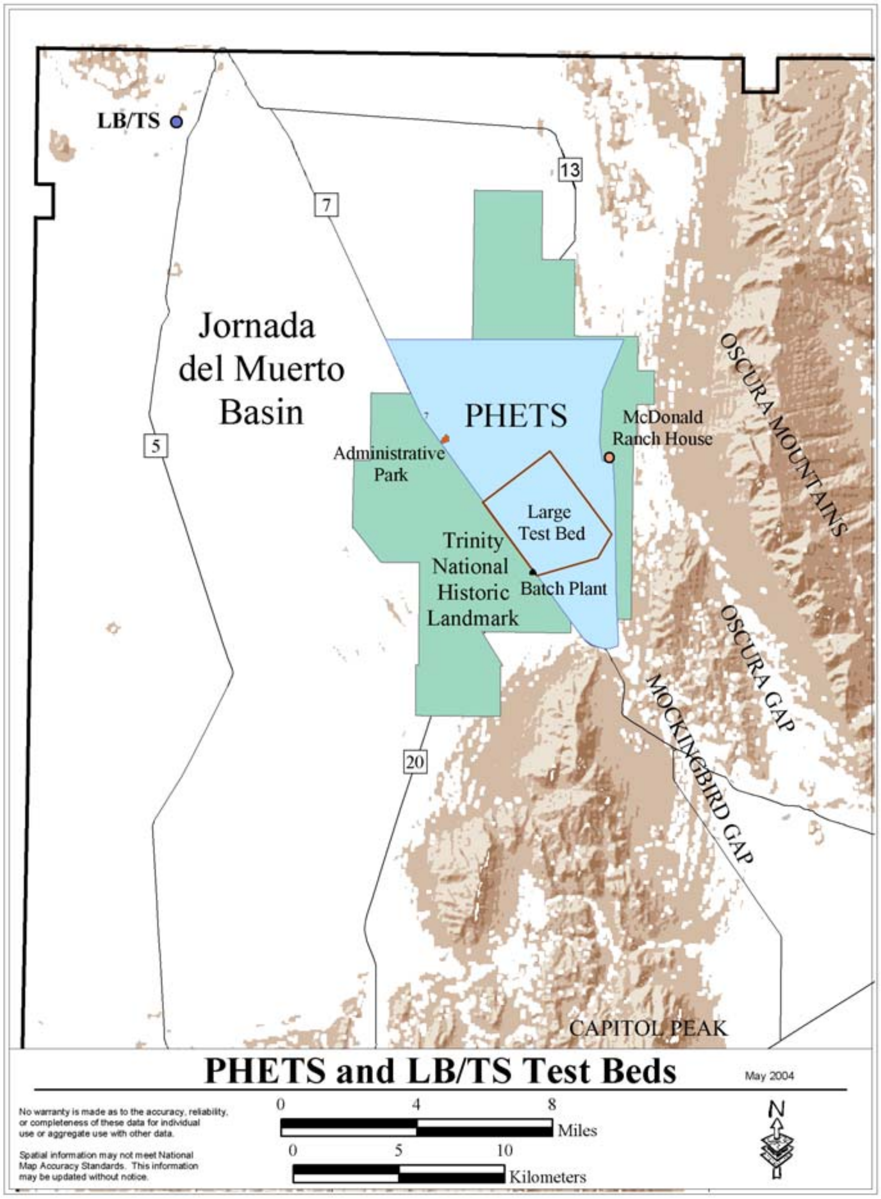


Figure 3-2. PHETS and LB/TS test sites.

landfill, and other manmade structures. The test beds contain numerous craters, depressions, mounds, and scraped areas as a result of past test activities. Elevation ranges from 1,418 m (4,652 ft) at monitoring well MW00-1 located at the Intermediate Test Bed to 1,554 m (5,098 ft) at the southern end of the site (Figure 3-3).

LB/TS is also located in the northern portion of the Jornada del Muerto Basin approximately 3.4 km (2.1 mi) southwest of the Stallion Range Center, 19 km (12 mi) northwest of PHETS, and 3.5 km (2.2 mi) south of the nearest WSMR boundary. The site covers approximately 20 ha (50 ac) and is located in a rolling sandy basin-floor setting at an elevation of 1,500 m (4,921 ft) above MSL, with the nearest mountains approximately 27 km (17 mi) to the east. LB/TS contains a large building complex and parking areas.

East of the Jornada del Muerto Basin and the San Andres Mountains, the Tularosa Basin encompasses the bulk of the WSMR land area (Figure 3-1). The San Andres Mountains form the western boundary of this basin, and the Sacramento Mountains (not on WSMR) the eastern. The basin extends north-south for approximately 240 km (150 mi), has a maximum width of approximately 97 km (60 mi), and covers an area of approximately 1,554,000 ha (3,839,985 ac). The Tularosa Basin is a closed basin, and its interior contains extensive nearly level alkali flats and gypsum sands at an elevation of approximately 1,220 m (4,000 ft) above MSL.

The San Andres Mountains are the most prominent mountain range on WSMR. These mountains extend 129 km (80 mi) along the western edge of the Tularosa Basin and rise more than 1,548 m (5,079 ft) above the bottom of the basin (Kottlowski et al., 1965; Kottlowski, 1975). The San Andres Mountains are dissected by small interior valleys that generally run north-south, and small canyons that run east-west off these valleys and the eastern and western slopes of the mountain range (WSMR, 2001). Salinas Peak, the highest point on WSMR (2,730 m [8,958 ft] above MSL), is located within the northern San Andres Mountains. Three DTRA test sites are located in the northern portion of this range (Figure 3-1).

The Hard Target Defeat (HTD) test beds are located below Capitol Peak in the northern portion of the San Andres Mountains. Capitol Peak is in the northeastern corner of Sierra County, approximately 129 km (80 mi) north of WSMR Main Post and 48 km (30 mi) south of Stallion Range Center. The HTD test beds are located on a north- to northwest-facing slope at elevations ranging from 1,463-1,829 m (4,800-6,001 ft). The slope at the lower portion of the site is approximately 2-5 percent up to an elevation of approximately 1,585 m (5,200 ft); and above this point the slope dramatically increases to 10-35 percent, forming an escarpment. The natural topography at this site has been and is currently

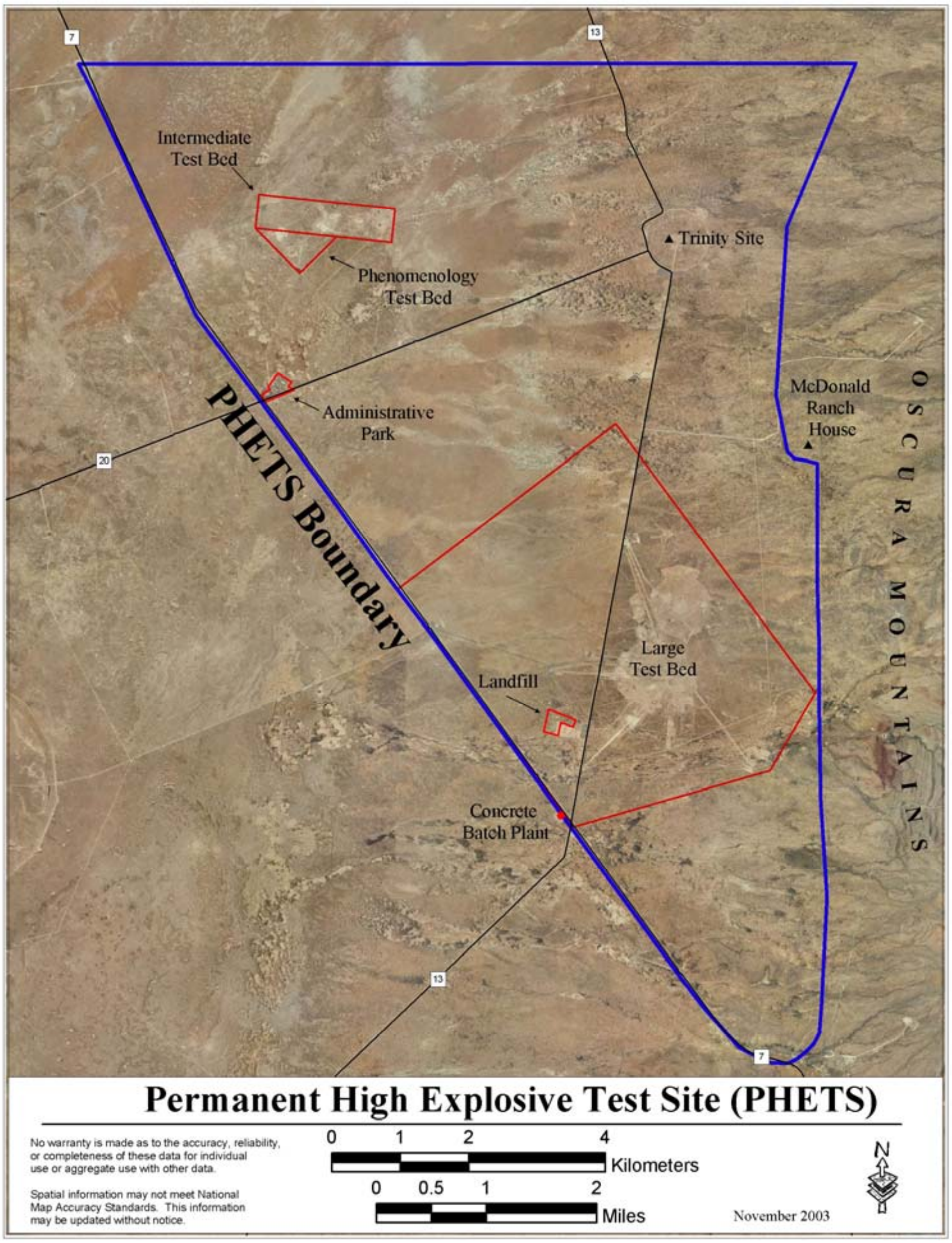


Figure 3-3. Map of PHETS.

being altered by activities associated with construction of target tunnels, including: large excavated spoil piles, road networks, and staging areas for construction equipment and temporary buildings. The entire site covers approximately 158 ha (391 ac).

Smaller mountain ranges adjoin the northern and southern ends of the San Andres range, and together these mountains form an almost continuous north-south-trending range that divides the Jornada del Muerto and Tularosa basins. These smaller mountain ranges include the San Augustin and Organ mountains to the south of the San Andres range, and the Oscura, Mockingbird, and the Little Burro mountains to the north (Figure 3-1). The Alt. SHIST site is located in the Mockingbird Mountains, and the SHIST site is located in the Oscura Mountains.

Alt. SHIST site is situated on a piedmont slope located in the Mockingbird Mountains in the northern portion of the San Andres Range. The site is gently sloping, decreasing in elevation in a north-northeast direction. Alt. SHIST site is located in Sierra County approximately 26 km southeast of PHETS, and covers a 7 ha (17 ac) area. Elevation is approximately 1,463 m (4,800 ft). This site has been used in support of bedrock penetration testing and the topography currently contains numerous craters and mounds of excavated material, and the main test bed area has been scraped clear of vegetation.

The Oscura Mountains and adjoining Chupadera Mesa cover the northeast corner of WSMR (Figure 3-1). The Oscura Mountains reach an elevation of 2,650 m (8,700 ft) at Oscura Peak. The west side of the range forms a steep escarpment; the east side gently dips to the northeast toward Chupadera Mesa, which extends beyond WSMR boundaries into the Northern Extension. (The Northern Extension is an area outside of WSMR boundaries that can be used for certain non-explosive testing activities under pre-existing agreements with the landowners.)

SHIST site is situated on a piedmont slope located on the western side of the Oscura Mountains south of Oscura Gap. SHIST site is located in Lincoln County 23 km (14 mi) southeast of PHETS and covers approximately 23 ha (57 ac). The site is moderately to steeply sloping, elevation and slope increase to the northeast, and overland drainage is to the southwest into the Tularosa Basin. Elevation is approximately 1,524 m (5,000 ft). This site has been used for on-going bedrock penetration testing and the main test bed area has been scraped clear of vegetation. The topography currently contains numerous craters and mounds of excavated material.

There are several additional major topographic features that occur within the overall basin and range regional topography of WSMR. The Carrizozo lava flows occur in the

northeast portion of WSMR, and the Armendaris lava flows in the northwest. These extensive basalt flows are nearly flat lying, and feature jagged, blocky surfaces. The south-central portion of WSMR is predominately covered by gypsum sand dunes and playa lakebeds that form flat or nearly flat surfaces. The gypsum sand dunes comprise the largest gypsum dune field in the world [111,976 ha (432 mi^2)] and mostly occur within WSMR; these dunes also extend southward into White Sands National Monument. Lowland playas and barren alluvial flats comprise nearly 21,000 ha (52,000 ac) in the Tularosa and northern Jornada del Muerto basins. These sites are usually dry and barren, except when submerged by water during heavy summer rains. Lake Lucero, a large playa lake, is a prominent topographic feature in the Tularosa Basin. The lake is typically dry except during times of substantial rainfall.

SHIST (source: J. Fraher, DTRA).

3.1.2 Aesthetics and Visual Resources

There are no laws or regulations that apply specifically to aesthetics and visual resources relevant to this PEIS.

WSMR has considerable aesthetic and visual resources within its boundaries and merging into surrounding areas. Scenic desert landscapes with rugged topography are typical. High mountains with sheer rock faces contrast with broad, flat basins creating much visual appeal. Nearby White Sands National Monument is a beautiful expanse of white gypsum sand dunes whose sand supply is derived from Lake Lucero, a largely barren playa lakebed. However, most of the WSMR landscape is not readily viewable by the general public due to access restrictions.

Scenic desert landscapes with rugged topography are typical.

PHETS is part of a larger area that has been used for high explosive tests, bombing, and missile impacts since the creation of WSMR in the 1940s. PHETS is located within the boundaries of a 19,976 hectare (ha) [49,360 acre (ac)] portion of WSMR designated as the Trinity Site National Historic Landmark (Trinity NHL). PHETS test beds and infrastructure can be seen from the Trinity NHL monument, which is open to visitors for one day twice a year. PHETS is located within the Jornada del Muerto Basin. It is a remote area with a stark and expansive landscape; viewed from the Jornada del Muerto Basin, the Oscura and San Andres Mountains create a scenic backdrop to the east.

PHETS and the surrounding area have an overall disturbed appearance as a result of extensive historic use. High explosive testing at PHETS began with the DICE THROW test in 1976 and has continued until the present day. Active disturbance at PHETS is limited to three primary test beds containing nonpermanent single and multiple story test structures, test support equipment, berms, and an established road network. Berms and other light-colored bare soil areas are visually prominent against a background of natural vegetation. An administrative complex is located at the intersection of Range Roads 7 and 20. Located near PHETS are several impact areas including Stallion WIT, 649 WIT, and the Northeast Center Impact Area (NECI). Many test programs launch missiles from the southern portion of WSMR into these northern impact areas. As a result of continuous mechanical ground-clearing activities, the impact areas have a disturbed appearance.

SHIST and Alt. SHIST have been used for projectile penetration testing since the early 1990s. Earth-moving activities associated with projectile recovery have noticeably altered the appearance of the land surface. Fresh rock and bare soil areas contrast sharply with vegetated areas. Evidence of historic and on-going DoD activities is visible from access roads to both sites.

The immediate area surrounding various test beds has been altered from historic use and contains support roads, target bunkers, and tunnels.

The HTD test beds are located in Capitol Peak area, a relatively remote mountain setting. The excavation of target tunnels and the resultant large spoil piles have altered the landscape. In addition, construction of a road network, several staging areas for equipment and temporary buildings have altered the appearance of the landscape. The lower part of Capitol Canyon and a portion of the project site can be partially seen from Range Road 7 about 8 km (5 mi) distant. However, other than the access road, there are no routinely utilized facilities from which the project area can be viewed. This site is beyond the visual range of visitors to WSMR.

The LB/TS is a 20 ha (50 ac) complex located in a remote basin-floor desert-shrubland setting. The site includes a one-story reinforced-concrete administration and control building, several other large buildings related to facility operation, and a roughly 250 m (820 ft) long semicircular shock tube surrounded by 8-ft earthen berms. The LB/TS can be glimpsed from Stallion Range Center and Range Road 7, both about 3.4 km (2.1 mi) distant. A 7-ft chain link security fence encloses the large building complex and parking areas.

3.1.3 Climate

There are no laws or regulations that apply specifically to climate relevant to this PEIS.

WSMR climate is typical of the northern Chihuahuan Desert. Summer is hot, and fall, winter, and spring are typically mild. There is a consistent pattern of strong westerly winds in the spring. Skies are usually clear, and most precipitation occurs during thunderstorms in the late summer. However, daily and annual temperature and precipitation vary considerably, and weather patterns can be difficult to predict (Goudie and Wilkinson, 1977). Although overall climate can be generalized, WSMR contains many "microclimates" that may vary significantly from one to another even within the same climate zone. Vegetation patterns often reflect these subtle differences in microclimate (Dick-Peddie, 1993). Wind exposure and topographic relief mostly cause these small-scale variations, and slight changes in elevation affect the temperature and precipitation levels in the landscape (WSMR, 2000a).

The climate at White Sands Missile Range is typical of the northern Chihuahuan Desert, with hot summer and mild fall, winter, and spring.

WSMR temperatures are generally mild and influenced by elevation (U.S. Army, 2002). The warmest WSMR temperatures are reached in July and average highs range from 33 to 34 °C (92 to 93 °F). The lowest temperatures are reached in January and average low temperatures in January range from –6 to 1 °C (21 to 34 °F). Summertime temperatures often exceed 38 °C (100 ºF) and wintertime nighttime temperatures often drop below freezing (U.S. Army, 2002). Mean annual temperature at the WSMR Main Post (elevation 4,250 ft) was reported as 17 °C (62 ºF) (Hatfield and Koperski, 2000). Higher elevations are typically cooler on average. In general, temperature drops 2.8 °C (5 °F) for every 300 m (1,000 ft) rise in elevation (Dick-Peddie, 1993). Average temperatures recorded at two WSMR surface meteorological stations (the Surface Atmosphere Measuring System) during July 2000 illustrate the effect of elevation on temperature. The average July temperature at an elevation of 1,221 m (4,005 ft) was 28 °C (83 °F), with a maximum of 40 °C (104 °F); whereas during the same timeframe the average temperature at Salinas Peak, at an elevation of 2,725 m (8,941 ft), was 18 °C (64 °F), with a maximum of 27 °C (81 °F) (U.S. Army, 2002).

Approximately 60 percent of the total annual rainfall occurs during the summer "monsoon" season, and most of the remaining portion during the winter and spring months. Summer rainfall is often in the form of intense, localized convectional thunderstorms that are generated in the Gulf of Mexico. These summer storms are

typically high intensity and short duration events that are not generally ideal for plant growth due to high evapotranspiration and rapid runoff. Winter storms, originating mostly from the Pacific Ocean, are generally less intense and longer in duration than summer storms. Mean annual precipitation in the basins is less than 25 cm (10 in), increasing to approximately 41 cm (16 in) at higher mountain elevations (U.S. Army, 2002). Natural vegetation has evolved under these conditions and developed mechanisms to maximize the benefits of this erratic precipitation (Dick-Peddie, 1993).

The elevations of PHETS, LB/TS, Capitol Peak HTD, SHIST, and Alt. SHIST are close to the general divide in elevation that separates arid and semi-arid climates, which is approximately 1,520 m (4,990 ft) (Schmidt, 1979). The ZURF weather station near PHETS reported precipitation ranging between 14.0 to 38.9 cm/year (5.5 to 15.3 in/year) over a five-year period (1996-2000), with an average annual precipitation of 25.1 cm. (9.9 in). Stations at higher elevations near SHIST and Alt. SHIST reported higher precipitation levels. The Duquette station near the eastern boundary of PHETS and closest to SHIST, reported rainfall ranging from 21.3 to 34.3 cm (8.4 to 13.5 in) with an annual average of 28.7 cm (11.3 in). The Mockingbird Gap station, north of Alt. SHIST, showed precipitation ranging from 18.5 to 39.6 cm (7.3 to 15.6 in) and averaging 30.7 cm (12.1 in) annually.

Strong westerly winds frequently occur from late February through early May, and these inhibit movement into the area of precipitation from the Gulf of Mexico. The spring winds sometimes raise large amounts of dust and sand from the soil surface in areas with sparse vegetation, causing occasional severe dust storms. Dust storms occur most frequently in March and April, and more rarely in other months (Eschrich, 1992). During the year, the prevailing wind direction varies from north to south to west. From June to October the prevailing winds are usually from the south, but they can vary and be from the north or the west (U.S. Army, 2002).

3.1.4 Geology and Soils

There are no laws or regulations that apply specifically to geology and soils relevant to this PEIS.

Two DTRA sites, LB/TS and PHETS are situated on sediments in the Jornada del Muerto Basin. The basin was formed by a syncline (a down-warped region of the earth's crust) and subsequently filled by a thick sequence of Santa Fe Group (Tertiary-Quaternary) and Late Quaternary sediments. These deposits were formed by a combination of geologic processes: alluvial (by moving water), lacustrine (in lakes), and eolian (wind-generated).

The materials are comprised of interbedded sands, silts, and clays. In addition, alluvial fan deposits slope westward from the nearby Mockingbird Gap Hills and Oscura Mountains and taper into the basin. Throughout much of the basin there are low-lying dunes and sheet deposits of gypsum and quartz sands that were formed by wind activity in the Late Holocene. Evidence of playas and lake plains (vegetated former lake bed surfaces [Peterson, 1981]), consisting of mostly silt deposits, is also visible in the basin.

The soils from the middle to the western edge of the Jornada del Muerto Basin are mapped as Onite-Bluepoint-Wink and Yesum-Holloman associations (USDA, 1976). These soils are highly susceptible to erosion when subjected to disturbances. Coarser alluvial sediments make up the Marcial-Ubar, Berino-Doña Ana, and Nickel-Tencee associations (USDA, 1976), which occur closer to the San Andres and Oscura mountains.

Much of PHETS sits atop sediments deposited by Pleistocene Lake Trinity, which was a perennial lake during the last glacial maximum (approximately 18,000 years before present) (Neal, 1976). There are no bedrock exposures within the PHETS boundaries. However, Permian rocks are exposed in the Mockingbird Gap Hills immediately east of PHETS, and it can be inferred that these also underlie the sediments in much of the PHETS area (Weir, 1965, Plate 1). The overall depth to bedrock beneath the alluvial cover has been reported at over 122 m (400 ft) (McMullan and Gould, 1987).

The Nickel-Tencee soil association occurs extensively throughout the eastern margins of PHETS, mainly on alluvial fans derived from the nearby mountains (USDA, 1976). Soils within this association include gravelly fine sandy loam (Nickel) and very gravelly loam (Tencee). West of the Nickel-Tencee occurrence, the Berino-Dona Ana association (mostly sandy loams) is perhaps the most extensive soil-mapping unit within PHETS. Other soil-mapping units occurring at PHETS are Yesum-Holloman association, Lozier-Rock outcrop complex, and Gilland-Rock outcrop complex (USDA, 1976).

Alt. SHIST and the HTD test beds at Capitol Peak are located in the San Andres Mountains. The San Andres is a fault-block mountain range dissected by numerous north-south-trending faults throughout the area. Rocks in this region range from Precambrian granite to Permian-Pennsylvanian Panther Seep Formation (Bachman and Harbour, 1970). Quaternary alluvium occurs in the bottoms of canyons and valleys between bedrock outcrops.

The upper boundary of the HTD test beds on the flanks of Capitol Peak occurs at the contact between granite and a sequence of generally darker, cliff forming Paleozoic rocks (Bachman, 1968). The west side of Capitol Canyon consists of a section of

Pennsylvanian Lead Camp Limestone. These rocks form massive cliffs and contain beds of chert and shale.

Capitol Peak (and the HTD test beds) lies within the Salinas Peak mining district and contains scattered small mineral deposits. A shallow pit near Capitol Peak had low assays reported (McLemore, 2002). The proposed Mockingbird South test bed is near the Mockingbird Gap mine, which contains copper, silver, lead, and zinc minerals. The Mockingbird Gap mining district (in which the mine is located) produced silver and lead from 1934-1941 but the deposits are typically small, low-grade, and uneconomic (McLemore, 2002). The Independence mine farther north in Mockingbird Gap, produced small amounts of similar metals.

Soils formed on the bedrock outcrops at Capitol Peak (typically as cliffs, ledges, and escarpments) have been mapped as Rock land, warm and Rock land, cool (USDA, 1976). Soils within these mapping units are shallow, and interspersed between abundant rock fragments and boulders. The two rock outcrop soils are mapped primarily by elevation differences: Rock land, warm occurs at elevations 4,300 to 6,500 ft ASL; Rock land, cool is found at elevations 6,000 to 8,000 ft ASL (USDA, 1976).

North of the HTD test beds, Alt. SHIST is situated on a gently sloping exposure of Precambrian granite, which is locally covered by a veneer of Quaternary alluvium (Bachman and Harbour, 1970). Immediately west of the site, an outcrop of Pennsylvanian Lead Camp Limestone occurs adjacent to a buried fault contact with the granite. The soil mapping unit for Alt. SHIST is designated Rockland, warm (USDA, 1976). Soils are thin and stony, and occur in patches atop the underlying granite bedrock.

Weathered granite outcrop at Alt. SHIST (source: Walcoff Environmental, WSMR).

SHIST Site is located on the western flanks of the Oscura Mountains, a northeast-dipping fault block range. The site lies mainly atop Precambrian granite, partially covered by a veneer of Quaternary alluvium. To the east and upslope, the site terminates in a section of lower Paleozoic marine sedimentary rocks. Quaternary alluvial fans cover the western part of the site, grading toward the main local drainage. The western boundary fault of the Oscura Mountains lies buried beneath alluvium west of SHIST, where Precambrian granite is in fault contact with younger upper Paleozoic rocks (inferred from Bachman, 1968). SHIST is in the Rockland, cool soil mapping unit that includes bedrock exposures, stony land, and shallow soils interspersed between rock outcrops (USDA, 1976).

3.1.5 Seismicity

There are no laws or regulations that apply specifically to seismicity relevant to this PEIS.

The terms “seismicity” and “seismic” are commonly found throughout this document. Seismicity pertains to large-scale earth movements that generate earthquakes. The term “seismic” as found in the title “Seismic Hardrock In Situ Test” (SHIST), refers to seismic measurements that are taken during rock penetrating tests in order to evaluate penetration capabilities of various weapons systems. These seismic measurements relate only to the sound waves produced from rock penetrating tests and are not related the earth movements that generate earthquakes (seismicity).

Seismicity in the context of the following discussion pertains to large-scale earth movements that generate earthquakes. White Sands Missile Range is located in the Rio Grande Rift, a region characterized by active movement along faults and earthquakes. The Rio Grande Rift is a major break in the Earth’s crust that starts in central Colorado and runs southward through New Mexico and into the Mexican State of Chihuahua. The rift was formed 29 million years ago when a section of the Earth’s crust arched, weakened, and spread apart due to heat from magma (molten rock) welling up from deeper depths (Chapin and Cather, 1994). Faulting began with the onset of rifting, causing earthquakes along certain areas of the rift zone. Faulting and associated earthquakes continue today as the Rio Grande Rift continues to widen (Sanford et al., 2000).

In the WSMR area, expansion along the rift has resulted in major faults located at the eastern and western boundaries of the Tularosa Basin. Three of these major fault zones occur partly within WSMR boundaries (Krinitzsky and Dunbar, 1988; Machette et al., 2000). The western Tularosa Basin fault zone occurs along the eastern base of the San Andres, Organ, and Franklin mountains. Faults in this zone have moved during the late Pleistocene epoch (2 million to 8,000 years ago) and/or early Holocene epoch (within the last 8,000 years) (Machette, 1987). The eastern Tularosa fault zone is identified by the Alamogordo fault located along the base of the Sacramento Mountains. Studies along this fault identify movement during the Pleistocene and possibly the Holocene (Machette, 1987). The third fault zone primarily comprises surface faults occurring within the Tularosa Basin east of the Organ Mountains. Movement along these faults has occurred within the last 750,000 years (Machette et al., 2000) and may be in response to activity along the major Tularosa fault zones (Seager, 1981). No major fault zones have been

identified within WSMR boundaries west of the San Andres Mountains and in the Jornada del Muerto Basin (Machette et al., 2000).

Only two earthquakes greater than magnitude III (on the Modified Mercalli Intensity Scale) have occurred within the boundaries of WSMR since 1869 (Sanford et al., 2000). Earthquake effects as measured on the modified Mercalli scale are classified as ranging from none that are noticed by people (magnitude I) to total damage to all structures (magnitude XII). During a magnitude III earthquake many people indoors feel movement, hanging objects swing back and forth, but people outdoors might not realize that an earthquake is occurring. During a stronger magnitude IV earthquake most people indoors feel movement, hanging objects swing, dishes, windows, doors rattle, a few people outdoors may feel movement, but there is no structural damage to buildings. Thus, the two strongest recorded WSMR earthquakes caused effects less than those listed for magnitude IV seismic events and were considered minor.

Although only minor earthquakes have occurred within WSMR boundaries during historical times, based on the geological and seismological history of the area the possibility of a major earthquake exists (Krinitzsky and Dunbar, 1988). Machette et al. (2000) analyzed the long history of recurrent movements along the major Quaternary (1.8 million years ago to present) faults that comprise the western Tularosa fault system. They estimated that a major surface-rupturing earthquake ($M>6.5$), caused by reactivation of pre-existing faults, could affect WSMR about once every 2,000-4,000 years. (During a magnitude VI earthquake everyone feels movement, people have trouble walking, objects fall from shelves, pictures fall off walls, furniture moves, plaster in walls might crack, trees and bushes shake, poorly built buildings are slightly damaged, but no structural damage occurs in well-built buildings.) However, because most Quaternary faults in the rift have long recurrence intervals (>50,000 to 250,000 years) and low movement rates (Wong et al., 2001), the risk of a major earthquake on WSMR is low. This is consistent with occurrence of primarily low– to moderate-magnitude ($M<6$) earthquakes that have been recorded or felt historically in New Mexico (Wong et al., 2001).

Although earthquakes associated with faults have occurred in the rift, historical seismicity (1869 to present) has been diffuse and not well associated with active faults (Machette et al., 2000; Sanford et al., 2000). The area surrounding Socorro has numerous earthquakes caused by a slowly rising body of magma, which is 19 km below the surface and approximately 150 m thick (Sanford et al., 2000). This seismically active region, called the Socorro Seismic Anomaly (SSA), covers an area of about 3400 km^2 (Sanford et al., 2000). The SSA occupies only about 1.6% of the total area of the state but

accounts for about 40% of the seismicity (Sanford et al., 2000). This highly active region extends as far south as San Antonio, NM (Sanford et al., 2000), which is about 10 km north of the northwest corner of the WSMR boundary.

Earthquakes in the Socorro area are unrelated to the fault zones within WSMR.

The frequent earthquakes in the SSA are caused by stresses arising from stretching of the Earth's crust over the inflating magma body, and not associated with rift faults (Sanford et al., 2000; Lin et al., 1996; Lin and Sanford, 1998). Furthermore, earthquakes in the SSA are unrelated to movement along the identified major rift-related fault zones within WSMR, the closest of which is located 70 km away in the Tularosa Basin (Machette et al., 2000). However, movement of the magma body within the SSA likely caused the historical earthquakes (M<3) located in the far northwest corner of WSMR (Machette et al., 2000).

3.1.6 Water Resources

Water resources are protected under the Clean Water Act (Federal Water Pollution Control Act), Safe Drinking Water Act, the Resource Conservation and Recovery Act (RCRA) and New Mexico Water Quality Regulations (20 NMAC 6.2). Under certain circumstances, the Environmental Protection Agency (EPA) issues permits under the National Pollutant Discharge Elimination System (NPDES) governing storm water discharges related to construction activities (WSMR is in EPA Region 6).

3.1.6.1 Watersheds

A watershed (also called a basin or sub-basin) is a land area in which all waters drain to the same destination. Watersheds form units that drain, store, filter, and capture water. Land areas are divided into hydrologic units by watersheds, and the abiotic and biotic components of these divisions function together. Importantly, any activity that affects water quality, quantity, or rate of flow at one location affects the rest of the watershed downstream.

Three regional watersheds are located within WSMR boundaries: the Jornada del Muerto, Tularosa Valley, and Jornada Draw basins. All three watersheds are closed basins. (Closed basins have no drainage outlet for surface water flow, and essentially all surface water is lost to evaporation.) The Jornada del Muerto Basin is located in the northwest portion of WSMR, and drains a 467,076 ha (1,893 mi^2) area, almost half of which is located within WSMR. The highest elevation points and headwaters of this basin system include portions of the San Andres Mountains, Mockingbird Mountains, Little Burro

Mountains, Oscura Mountains, and Chupadera Mesa (WSMR, 2001). The Tularosa Valley watershed (basin) drains most of the WSMR land area (1,710,575 ha [6,604 mi^2]). More than a third of the Tularosa Valley basin is located within the boundary of WSMR. The highest topographic relief of this watershed includes portions of the San Andres and Sacramento mountains. Water from the mountain front recharges the basin ground water, which is then lost to evaporation at Lake Lucero, the lowest portion of this closed basin system (WSMR, 2001). Only a narrow portion of the Jornada Draw watershed is located within WSMR. It drains 328,445 ha (1,268 mi^2), and the San Andres Mountains form the highest elevation within this basin (WSMR, 2001).

3.1.6.2 Surface Water

Surface water resources within WSMR are limited due to low rainfall, high evaporation rates (due to high temperature and low humidity), and high soil infiltration properties. Most streams, lakes, and rainwater catchments are ephemeral (not permanent) and are dependent on runoff from relatively infrequent precipitation events typical of the region. Surface water generally occurs as overland flow from occasional intense thunderstorms during summer, accumulating in natural or manmade depressions. The gently sloping topography and the tendency for water to evaporate quickly and rapidly percolate into underlying sandy alluvium promote relatively low runoff amounts at PHETS and LB/TS. Test beds in the more mountainous locations (SHIST, Alt. SHIST, and HTD) experience greater surface flow during the more intense precipitation events.

Surface water resources within WSMR are limited and water quality ranges from fresh to brine.

Surface water quality is variable and is measured as the concentration of dissolved minerals in the water, termed total dissolved solids (TDS). Freeze and Cherry (1979) classified waters according to their TDS concentrations as follows:

- Freshwater: <1,000 mg/L TDS
- Brackish water 1,000 to 10,000 mg/L TDS
- Saline water 10,000 to 100,000 mg/L TDS
- Brine water >100,000 mg/L TDS

Surface water quality in ephemeral water bodies ranges from fresh to brine, and can become more highly concentrated with TDS over time due to evaporation.

The northern Jornada del Muerto Basin has poorly defined and integrated surface water drainage, except within bedrock outcrops along the basin margins where water flows toward the basin center (Weir, 1965). Surface flow within this watershed is intermittent and depends on precipitation levels. Weir (1965) conducted the most comprehensive evaluation of water sources in the Jornada del Muerto Basin but no perennial springs or surface water sources were reported. There are many ephemeral lakes (playas) in the Jornada del Muerto Basin, and these provide seasonal water sources for wildlife.

The northern Tularosa Valley watershed has a better-integrated and defined drainage pattern than the Jornada del Muerto Basin (WSMR, 2001). The majority of runoff from the San Andres Mountains drains into the Tularosa Basin through approximately 14 large canyons (Kottlowski et al., 1956). Streambeds in the mountains have a rectangular drainage pattern, with major canyons formed perpendicular and tributary canyons formed parallel to the strike of the beds of sedimentary rocks (Kottlowski et al., 1956).

Salt Creek is the only major perennial stream on WSMR. It contains saline to brine water most of the time.

Perennial surface water bodies on WSMR are essentially limited to the Tularosa Basin, and Salt Creek is the only major perennial stream. Salt Creek is located in the northwestern portion of the basin and flows from north to south (Figure 3-5). The source of its water is brackish to saline shallow ground water flowing through the underlying alluvium.

Salt Creek (source: Walcoff Envrionmental, WSMR).

The stream flow eventually disappears into the ground or empties into the playas north of Lake Lucero. Lake Lucero is located in the southwestern portion of the basin, and it contains saline to brine water most of the time. Flow rate depends on precipitation runoff events and can quickly change. Stream flow measured (since 1995) at the USGS gauging station on Salt Creek, located at RR 316, showed a high of 2,492 L/s (88 ft^3/s) and a low of zero (WSMR, 2001). The water in Salt Creek has high

concentrations of TDS and is classified as saline, and water quality has been shown to depend on location and flow rate at time of collection (WSMR, 2001). There are several perennial ponds associated with Mound Springs and Malpais Spring (Figure 3-4), with Malpais Spring providing sufficient water to form a wetland.

There are no perennial streams or surface water bodies at the PHETS, LB/TS, SHIST, Capitol Peak, and Alt. SHIST sites. Several earthen water catchments, probably abandoned ranching-era stock tanks, are found at PHETS. Storm water runoff from PHETS drains westward across a broad alluvial plain and into ephemeral playa lakes in the central part of the Jornada del Muerto Basin.

Perennial and ephemeral seeps and springs occur throughout the San Andres and Oscura mountains. Capitol Peak and Alt. SHIST sites are located in the San Andres Mountains, and SHIST site is located approximately 7.5 km (4.7 mi) to the northeast in the Oscura Mountains. The closest major spring to Capitol Peak and Alt. SHIST is Russell Spring, which is located approximately 6 km (3.7 mi) to the south-southwest in Thrugood Canyon south of Capitol Peak. Wildlife watering units, which are mostly former ranch stock tanks, also periodically hold water. The watering unit at the old Burris Ranch in Burris Valley is located approximately 2.5 km (1.5 mi) west of both Capitol Canyon and Alt. SHIST sites. The closest major spring to SHIST site is Kidd and Duffy Spring, located about 5 km (3 mi) to the north-northeast of the test bed. Unlike for the springs in the Tularosa Basin that are potential habitat for the White Sands pupfish, there are little data available on the water quality of mountain springs (WSMR, 2001). All three sites drain toward the Tularosa Basin, and surface water flow patterns at Capitol Canyon and Alt. SHIST are presented in Figure 3-5.

3.1.6.3 Ground Water

Ground water on WSMR can occur in all lithologic units, ranging from Precambrian to Quaternary in age. Large amounts of water are contained in the Tertiary to Quaternary unconsolidated basin-fill and alluvial deposits in the Tularosa and Jornada del Muerto basins; these locally yield large amounts of water to wells and springs (Roybal, 1991). However, most of this water contains high concentrations of TDS and is of poor quality (Orr and Myers, 1986; Roybal, 1991; Weir, 1965). Rocks of Permian and Cretaceous ages yield small to moderate amounts of water from joints and fractures in a few localities (Weir, 1965). Weir (1965), Roybal (1991), and Brady *et al.* (1984) have provided detailed reports on the occurrence, movement, and quality of ground water and aquifer characteristics in the northern part of WSMR.

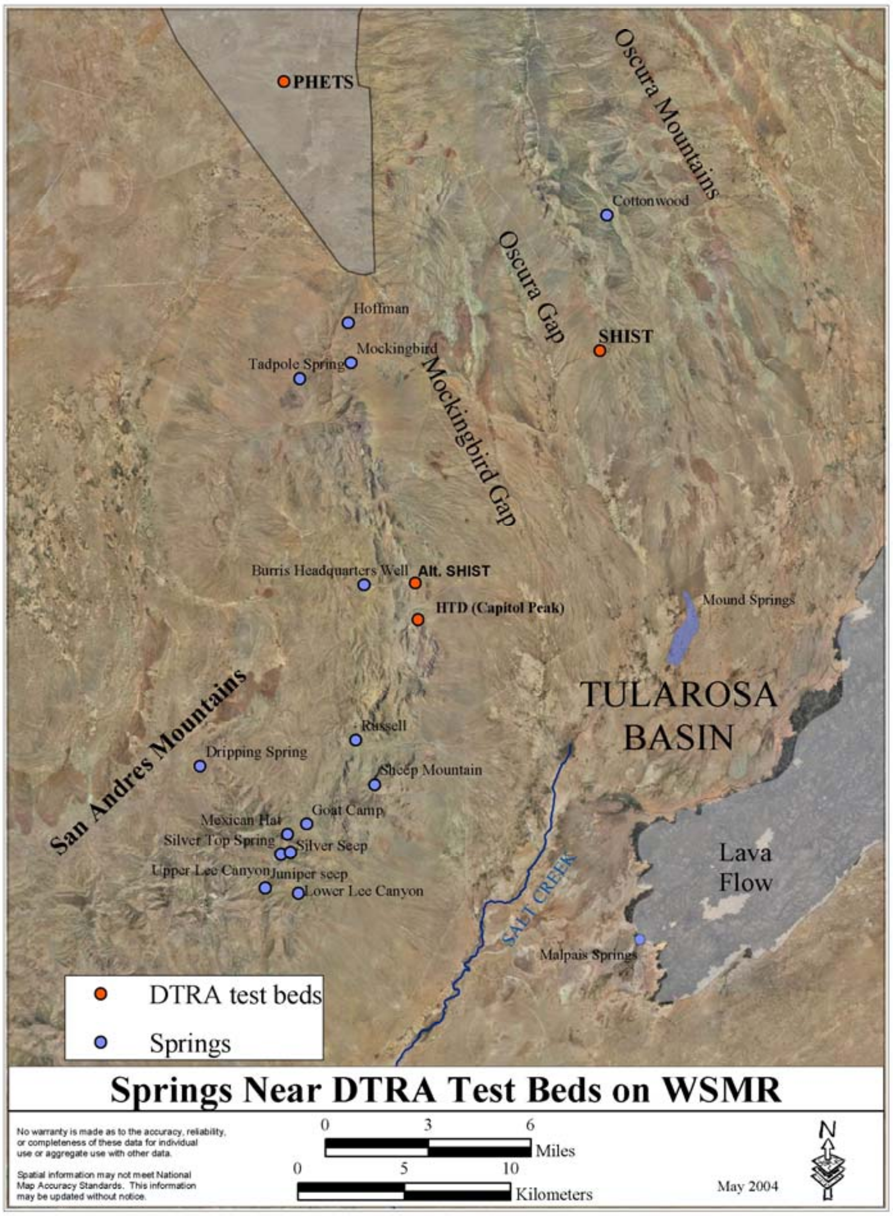


Figure 3-4. Springs in the vicinity of DTRA test beds on WSMR.

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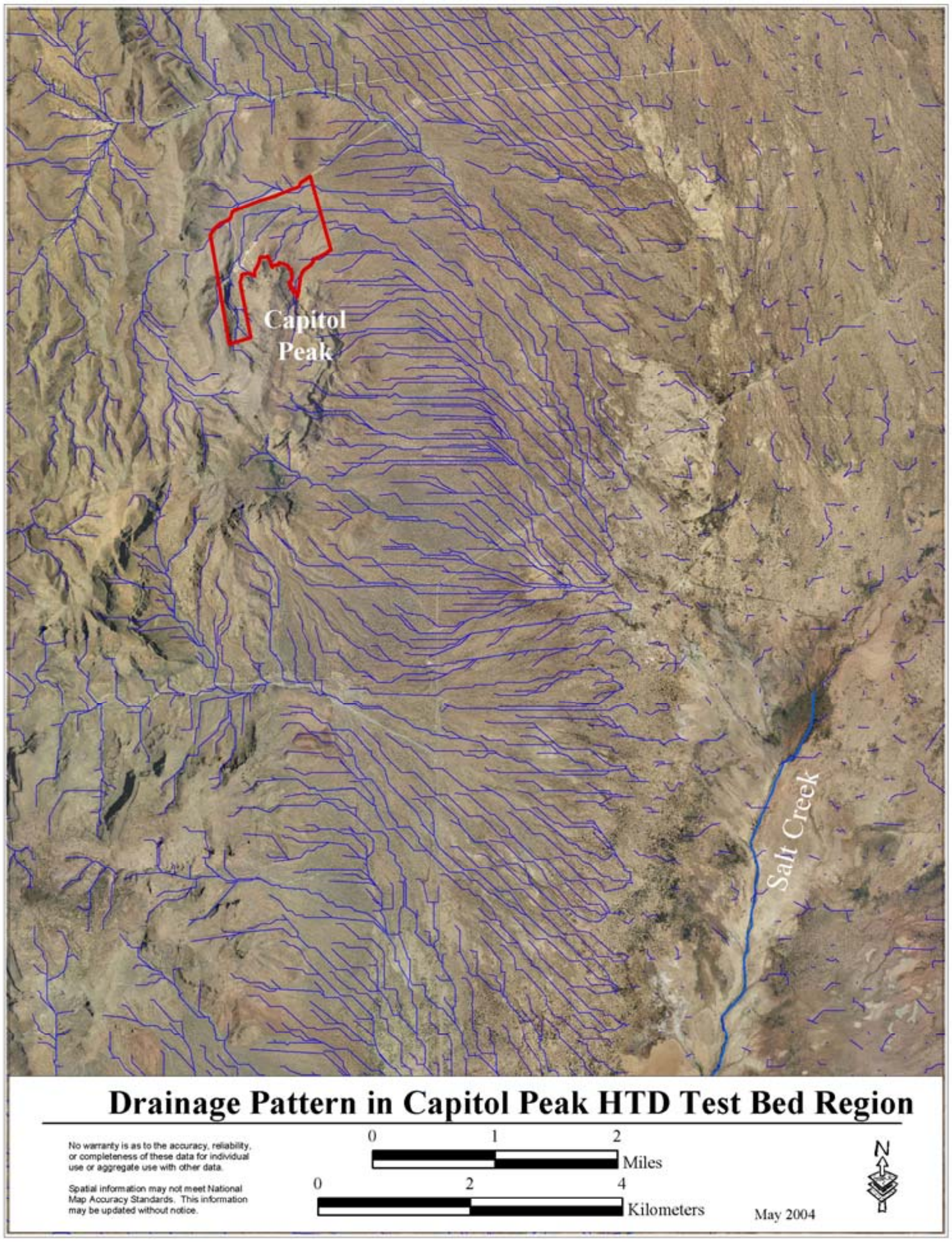


Figure 3-5. Drainage pattern in Capitol Peak HTD test bed region.

The major source of recharge to the ground water system occurs in areas adjacent to the mountain ranges. Runoff resulting from snowmelt or rainfall on relatively impermeable mountainous watersheds infiltrates the relatively permeable alluvial basin-fill deposits and recharges the ground water system (Roybal, 1991). Any discharge from the ground water system occurs from evaporation, evapotranspiration, wells, springs, seeps, and Salt Creek (WSMR, 2001).

The sediments in the Tularosa and Jornada del Muerto basins contain large amounts of water; however, almost all of this water is highly saline and poor quality.

The chemical quality of ground water in the northern part of WSMR is mostly poor because of the high concentrations of TDS, particularly sulfate, chloride, and sometimes nitrate (Weir, 1965). Small amounts of water of good to fair quality are present in wells and springs at a handful of localities (Weir, 1965); and ground water containing less than 1,000 mg/L TDS has been reported at points of recharge high in alluvial fans next to the mountain fronts (WSMR, 2001). However, TDS concentrations in most WSMR ground water exceeds 1,000 mg/L; more than 85% of ground water in the Tularosa Basin may contain TDS exceeding 3,000 mg/L (Orr and Myers, 1986), and TDS concentrations as high as 177,000 mg/L have been reported (WSMR, 2001).

In the Jornada del Muerto Basin where PHETS and LB/TS are located, ground water has been encountered in alluvial bolson deposits at between 4 to 178 m (13 to 584 ft) below ground surface (Roybal, 1991). In a well drilled in 1988 at the PHETS Administrative Park, ground water was reached at 19 m (62 ft) below the land surface. Depth to ground water measurements in other wells in the PHETS area have indicated widely varying water table depths, including: 4 m (13 ft) in the Story Well (Roybal, 1991); 14 m (46 ft) in the C. Green Well (Weir, 1965); 28 m (92 ft) in the Foster East Well; 59 m (194 ft) in the Murray Well; 105 m (344 ft) in the McDonald Headquarters Well (Weir, 1965); and 77 m (253 ft) in the DC-1 Well (USGS staff, 1985). Depth-to-water generally increases from west to east at PHETS, reflecting the increasing thickness of alluvium toward the Oscura Mountains.

The water table gradient in the Jornada del Muerto Basin slopes generally westward; thus subsurface water flows in this direction (Weir, 1965; Brady *et al.*, 1984). Overall, ground water at PHETS flows westward; however, local flow directions change from generally west-northwest in the southern portion of the site to the west-southwest in the northern portion (Roybal, 1991). Ground water flows to the west-southwest in the vicinity of LB/TS (Roybal, 1991).

Ground water monitoring wells were drilled at PHETS in 2000 and 2001 to evaluate possible testing-related cumulative impacts (U.S. Army, 2002). Figure 3-6 shows the location of these in the PHETS area. In the Intermediate Test Bed, monitoring well MW00-1 was completed to a depth of 27 m below the land surface and ground water was encountered at 22 m. Two other monitoring wells, MW00-2 and MW01-3 were drilled in the Large Test Bed. Ground water elevations in these wells were slightly higher, indicating a ground water flow direction toward the north-northwest (Figure 3-6). This interpretation of flow direction also agrees with the water table contour map of Weir (1965). Monitoring well MW00-2, located near the boundary of the proposed landfill expansion area, was finished at a total depth of 66 m and the water table was reached at 60 m below the surface. Monitoring well MW01-3 was completed upslope from the landfill and reached water at 77 m below the surface.

Drilling a monitoring well at PHETS (source: Walcoff Environmental, WSMR).

Chemical quality data reported in the literature for water from historic wells (Roybal, 1991; Weir, 1965) indicated that ground water throughout PHETS is non-potable and brackish (1,000-10,000 mg/L TDS). The Federal government regulates TDS concentrations in drinking water, and the secondary Maximum Contaminant Level (MCL) for TDS in drinking water is 500 mg/L (U.S. EPA, 1986). Chemical quality data from historic wells in the area show that TDS concentrations, *e.g.* 3,310; 3,520; and 3,700 mg/L (Weir, 1965; Roybal 1991) exceeded the Federal drinking water standard. In addition, sulfate concentrations in water from these wells ranged from approximately 2,200 to 2,500 mg/L. These concentrations were far higher than the 250 mg/L allowed by Federal drinking water regulations (U.S. EPA, 1986). In addition to TDS, high concentrations of sulfate make ground water in the region non-potable. The high concentration of dissolved solids and sulfate in the ground water in this region are a result of naturally occurring minerals that exist in the subsurface. Non-potable water for construction, project activities, or personnel use is trucked in from outside sources, usually from wells at Stallion Range Center. Potable water for DTRA and other actions occurring in the area would come from the desalinization plant at Stallion Range Center.

Selected analytical results from year 2001 sampling of the three monitoring wells (U.S. Army, 2002b) at PHETS are presented in Table 3-1. Sulfate, nitrate, and TDS content closely match historic well data for the area (Weir, 1965; Roybal, 1991). The chemical simulant triethyl phosphate (TEP) used in previous collateral damage tests (U.S. Army,

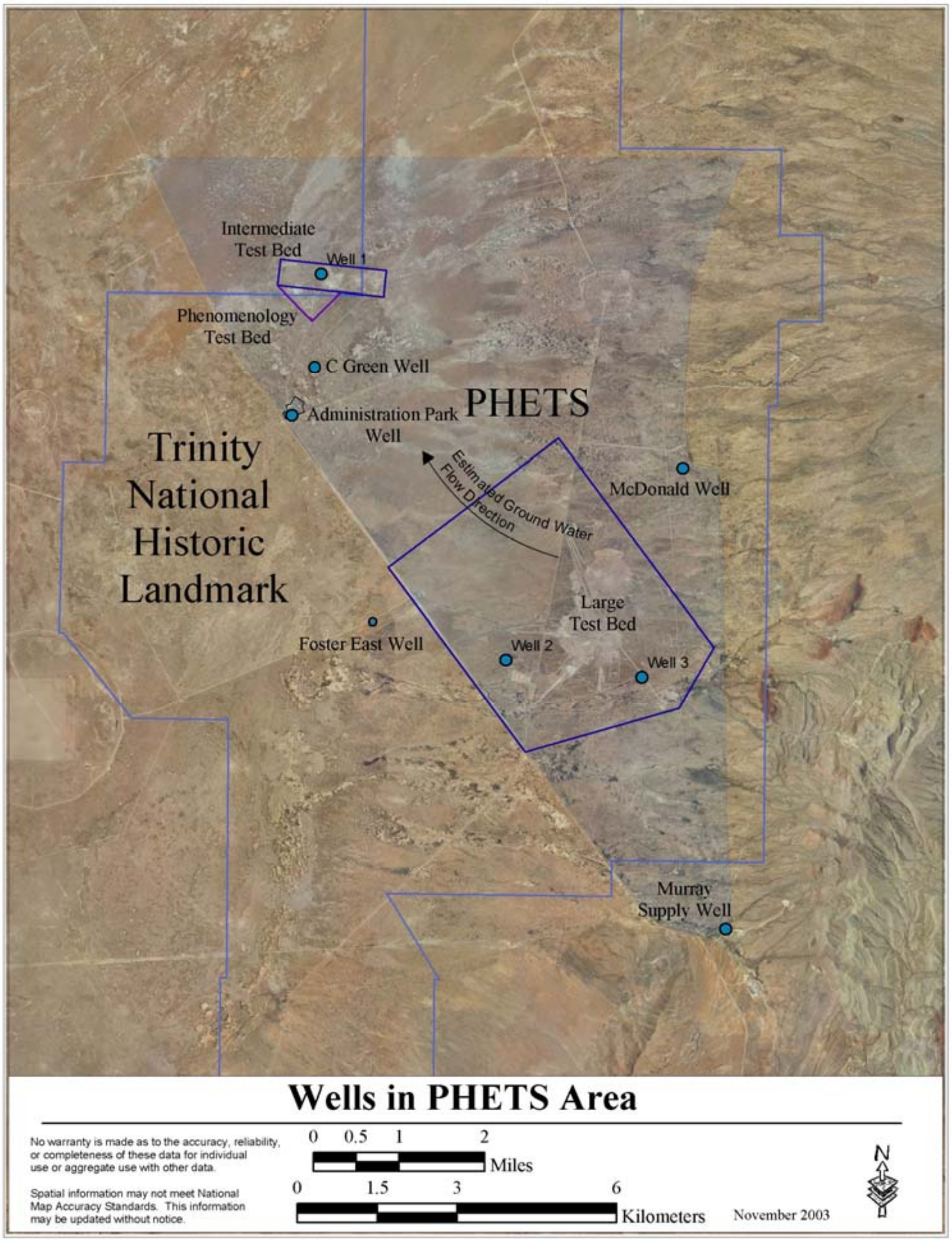


Figure 3-6. Wells in the PHETS area.

Table 3-1. Selected Analytical Results for PHETS Monitoring Wells.

Well Name (Depth to Water [ft])	UTMs (NAD83)	Sampling Date	TDS (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Petroleum Hydrocarbon In water (mg/L)	Triethyl Phosphate (μg/L)
MW 00-1 (71)	N3727733 E357836	06JUN2001	3289	2081	3.03	1.32	Not Detected
MW 00-2 (194)	N3720483 E361300	17OCT2001	3847	2536	8.8	0.0208	Not Detected
MW 01-3 (253)	N3721266 E363197	17OCT2001	3728	2260	10.7	0.177	Not Detected

2002b) was not detected in any of the samples. In addition, annual sampling and analysis of ground water at this test bed is planned to detect adverse trends in ground water quality (U.S. Army, 2002b).

Ground water at SHIST site is transitory and effectively limited by the shallow bedrock contact in the area. Alluvial cover within the SHIST boundaries ranges from 0 to approximately 15 m (49 ft). Ground water is expected to accumulate in the alluvium atop the bedrock following significant rainfall events but does not persist for long. In this area any subsurface water would flow southeastward into the Tularosa Basin (Weir, 1965). The Mockingbird Gap well is nearest to SHIST, with a reported depth to water of 23 m (75 ft) (Weir, 1965).

Alt. SHIST, located in the foothills north of Capitol Peak, is situated on granite bedrock covered by a veneer of alluvium in places. There are seismic boreholes drilled for past tests, but no water wells in the immediate vicinity. Burris Well, located approximately 1.6 km (1 mi) west of Alt. SHIST, was drilled in valley-fill alluvium and has a reported water table depth of 11 m (36 ft) and dissolved solids concentration of 1,290 mg/L (Weir, 1965).

In the HTD test bed area, depth to water from wells in the region, within approximately 15 km (9 mi), ranges from 6 to 42 m (20-138 ft). Any subsurface water would drain towards the Tularosa Basin.

3.2 Biological Resources

3.2.1 Flora

Variations in elevation and topography control much of the broad distribution of vegetation types on WSMR. Generally, increasing elevation equates to an increase in

moisture availability and a decrease in temperature, which in turn influence the type of vegetation occurring in a given area. The lowland areas of the Tularosa and Jornada del Muerto basins have lower moisture availability, resulting in lowland scrublands and grasslands. Woodlands and coniferous forests occur in the higher elevations of the San Andres and Oscura mountains due to higher moisture availability. Other factors that help create variations in vegetation communities include soil texture, aspect, latitude, annual precipitation, evaporation rates, and salinity (Dick-Peddie, 1993).

Variations in elevation and topography can affect moisture availability and temperature, influencing the broad distribution of vegetation types on WSMR.

The White Sands Missile Range Environment and Safety Directorate (WS-ES) enlisted the New Mexico Natural Heritage Program (NMNHP) to develop a vegetation classification system and a map of current upland vegetation of WSMR. The vegetation classification system and map were designed to provide high quality floral data for use in environmental review and planning. Specifically, the classification system and map are to provide baseline data for compliance with environmental laws such as the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA), as well as meeting inventory and classification requirements for natural resources management on WSMR. Information derived from this classification system and map allows users to model and predict locations of sensitive species and fragile habitats. This information was used in the development of this PEIS.

There are two volumes to the NMNHP report. Volume 1, *Handbook of Vegetation Communities*, is a vegetation classification system that provides information on the vegetation types of WSMR in a format that can be utilized both in field and planning applications. It contains detailed information on plant communities and habitats. A total of 193 plant associations were described from among 52 alliances. Of these, 71 were major associations with relatively wide distributions on WSMR and typically were primary components or inclusions in map units. Of the 193 plant associations 122 were minor types with limited mapped distributions (WSMR, 2000a).

Volume II provides a vegetative map of WSMR along with descriptions of map units. The map units represent combinations of vegetation communities. Both volumes are linked so as to maximize the use of ecological information in conjunction with spatial data. The vegetation map is composed of 34 major map units, which can further be divided into 95 subunits for greater detail of vegetation patterns (WSMR, 2000b).

A generalized map and table of WSMR vegetation types was created for this PEIS by combining the 34 major map units of volume II into floristically similar map units (Figure 3-7 and Table 3-2). Areas of military disturbance and roads are also major features noted on Figure 3-7.

PHETS is located in the northern Jornada del Muerto Basin and is dominated by four major vegetation types that are common to the area: mixed lowland desert scrub, lowland basin grassland, sandsage shrubland, and vegetated gypsum outcrop. These major vegetation types occur in extensive landscape patches throughout the PHETS area, with a mixed mosaic of vegetation types established in the southern end of the site. Within these types are small inclusions of mesquite shrubland, and larger inclusions of creosote shrubland and desert plains grassland.

The vegetation type around LB/TS is composed of sand sagebrush (*Artemisia filifolia*) shrubland, with an understory composed primarily of grass species such as black grama (*Bouteloua eriopoda*), bush muhly (*Muhlenbergia porteri*), and three awns (*Aristida* sp.).

SHIST Site contains species typical of creosote shrubland. This vegetation type occurs commonly on gravelly alluvial fan piedmont areas. In undisturbed areas at SHIST, creosotebush is the dominant shrub occurring with honey mesquite, fluffgrass and bush muhly. The military disturbance at SHIST includes areas of active testing with on-going recovery and reclamation taking place. These areas are bare or sparsely vegetated with colonizing species.

Table 3-2. Vegetative Mapping Units on WSMR

Map Units (refer to Figure 3-7)	Corresponding Map Units from WSMR Vegetation Map[1]
Vegetated Gypsum Dunelands	Gypsum Duneland-vegetated Vegetated Gypsum Outcrop
Grasslands	Black Grama Lava Grasslands Desert Plains Grasslands Foothill-Montane Temperate Grasslands Gypsum Interdune Swale Grasslands Lowland Basin Grasslands Mixed Foothill-Piedmont Desert Grasslands Piedmont Desert Grasslands Piedmont Temperate Grasslands

Table 3-2. (Continued).

Map Units (refer to Figure 3-7)	Corresponding Map Units from WSMR Vegetation Map[1]
Shrublands	Acacia Shrubland Creosotebush Shrubland Fourwing Saltbush Shrubland Interior Chaparral Malpais Lava Scrub Mesquite Shrubland Mimosa Shrubland Mixed Lowland Desert Shrub Montane Shrub Pickleweed Shrubland Sandsage Shrubland Tamarisk Shrubland Tarbush Shrubland
Woodlands	Juniper Woodland Montane Valley Dune Woodland Pinyon Pine Woodland Ponderosa Pine Forest
Military Disturbance	Military Disturbance
Non-Vegetated Areas	Alluvial Flats-barren Gypsum Duneland-barren Playa
Wetlands	Wetlands
Road Disturbance	Road Disturbance

[1] Adapted from The Vegetation of White Sands Missile Range, New Mexico, Volume II: Vegetation Map (WSMR, 2000b).

Alt. SHIST is situated in the northern part of the San Andres Mountains and has the vegetative characteristics of black grama grassland with sand sagebrush and creosotebush (*Larrea tridentata)* as the primary shrubs. The active testing area at Alt. SHIST is designated as military disturbance on the vegetation map and is relatively free of vegetation with only scattered grass and forb species present. There are two small arroyos crossing the site to the east and west of the active area. These arroyos contain riparian species such as Apache plume (*Fallugia paradoxa*) that are common to WSMR.

The Hard Target Defeat (HTD) test beds for tunnel targets are located in the northern end of the San Andres Mountains at Capitol Peak. The dominant vegetation community occurring in the Capitol Peak area is a shrubland composed primarily of creosotebush and mariola (*Parthenium incanum*). Creosotebush and mariola are found in abundance in the interfluves between the arroyos. In the arroyos, little-leaf sumac (*Rhus microphylla*), Apache plume, and sotol (*Dasylirion wheeleri*) are common. Black grama and beargrass (*Nolina microcarpa*) are common on the slopes that formed the mouth of Capitol Canyon. Within Capitol Canyon, sotol, Mormon tea (*Ephedra torreyana*), and black

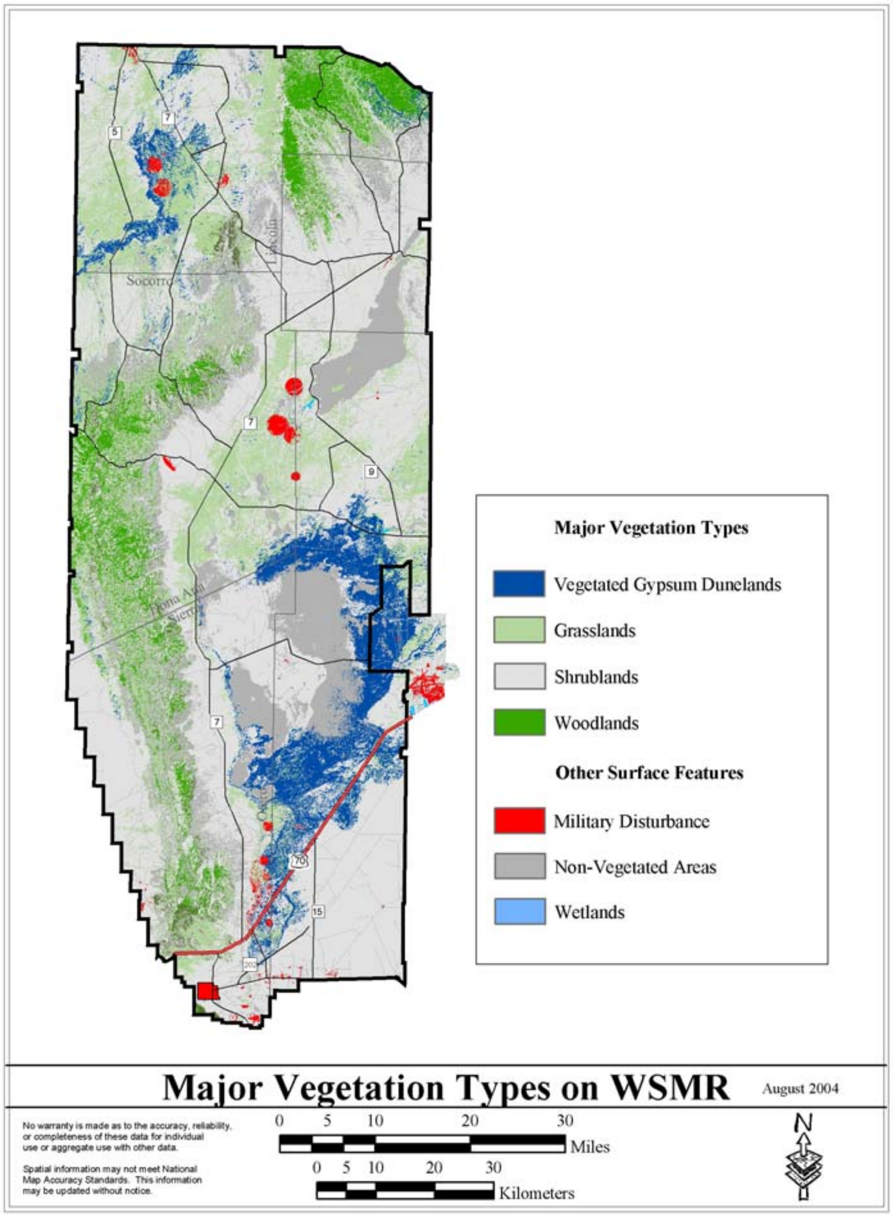


Figure 3-7. WSMR vegetation types.

grama (*Boutleoua eriopoda*) are the most common plant species. Escarpments, cliffs, and rock faces common to the area contain little or no vegetation.

3.2.2 Threatened, Endangered, or Sensitive Flora Species

A total of 61 floral species having Federal or State status occur or potentially occur on WSMR (Appendix C). Fifteen have been documented on WSMR, five having both Federal and State status and the other ten have only State status. These floral species are primarily restricted to mountainous habitat away from most WSMR testing activities.

Todsen's pennyroyal (*Hedeoma todsenii*) is the only Federal endangered floral species documented on WSMR. Six populations have been found on high pinyon-juniper slopes on Granddaddy Peak and the Chalk Hills on the western edge of the San Andres Mountains, on steep slopes at elevations between 1,980-2,010 m (6,500-6,600 ft) ASL. Todsen's pennyroyal has not been found on any of the active test sites on WSMR.

Fifteen floral species having Federal or State status have been documented on WSMR, but are primarily restricted to mountainous habitat away from most test activities.

There are four Federal listed floral species of concern occurring on WSMR, the desert night-blooming cereus (*Peniocereus greggii* var. *greggii*), Mescalero milkwort (*Polygala rimulicola* var. *mescalerorum*), Alamo beardtongue (*Penstemon alamosensis*), and Organ Mountain evening primrose (*Oenothera organensis*). Desert night-blooming cereus is widely distributed in gravelly soils of arroyos and lower piedmonts in the San Andres Mountains, while Mescalero milkwort and Alamo beardtongue are found at higher elevations on limestone slopes and cliffs. The Organ Mountain evening primrose has been identified in riparian habitats only in the Organ Mountains.

Todsen's pennyroyal is the only Federal endangered floral species documented on WSMR (source: Walcoff Environmental, WSMR).

The remaining 11 listed flora on WSMR are nominated as species of concern by the State of New Mexico and, while not protected by State statute, must be considered under Army Regulation 200-2. These species are mosquito plant (*Agastache cana*), cliff brittlebrush (*Apacheria chiricahuensis*), Castetter's milkvetch (*Astragalus castetteri*), Sandberg's pincushion cactus (*Escobaria sandbergii*), Vasey's bitterweed (*Hymenoxys vaseyi*), Organ Mountain evening

primrose, Alamo beardtongue, lanceleaf beardtongue (*Penstemon ramosus*), San Andres cross daisy (*Perityle staurophylla* var. *homoflora* and var. *staurophylla*), desert parsley (*Pseudocymopterus longiradiatus*), and Plank's catchfly (*Silene plankii*). All of these species are found in mountainous habitat associated with canyons, woodlands, cliffs, boulders, and rocky outcrops.

In addition, 46 floral species have been designated by WS-ES as WSMR species of interest (SOI). SOI species are plants that WS-ES monitors for location and abundance based on four criteria including: 1) previous Federal or State listing; 2) rarity on WSMR; 3) species useful for land rehabilitation; and 4) species with spatially restricted habitat. Although SOIs are not afforded legal protection, they are closely monitored by WS-ES. The majority of WSMR SOI floral species occur in mountainous habitat on WSMR; only eight SOI floral species occur on the basin floors. The eight SOIs occurring within the basins include claret cup cactus (*Echinocerrus triglochidiatus*); tall prairie gentian (*Eustoma exaltatum*); Trans-Pecos sea lavender (*Limonium limbatum*); club cholla (*Opuntia clavata*); gramagrass cactus (*Pediocactus papyracanthus);* New Mexico scorpion weed (*Phacelia neomexicana*); gypsumwort (*Pseudoclappia arenaria*); and Hot Springs globemallow (*Sphaeralcea polychroma*).

The San Andres rock daisy (*Perityle staurophylla*) was encountered at the Capitol Peak HTD test beds during survey efforts. The San Andres rock daisy, a New Mexico State sensitive plant, is found in cliff face habitats in the San Andres Mountains. The plant occupies cliffs between 1798–2072 m (5897-6796 ft) in elevation. WS–ES has been made aware of its presence in the HTD project area. However, this species, while having a State sensitive status, is afforded no special Federal or State protection.

WSMR floral species of interest (SOI) are not afforded legal protection but are closely monitored by White Sands Environmental Services.

Three WSMR SOI plant species can potentially occur in the HTD area: Cory joint-fir (*Ephedra coyri*), lanceleaf beardtongue (*Penstemon ramosus*), and pineapple cactus (*Neolloydia intertexta*). Pineapple cactus and lanceleaf beardtongue had a previous Federal or State listing, but have since been dropped from these lists. Cory joint–fir is a rare species on WSMR. No WSMR SOI plant species were located during survey efforts within the HTD area.

Pineapple cactus was the only WSMR SOI plant species found in the Mockingbird South area during biological surveys in September 2000 (U.S. Army, 2002a). WS-ES has been made aware of its presence in the region. Based on NMNHP data and information from

WS-ES four WSMR SOIs: Cory joint-fir, dagger thorn cholla, pineapple cactus, and gramagrass cactus may potentially occur within PHETS, SHIST, or Alt. SHIST test beds (Table 3-3).

Table 3-3. WSMR floral SOIs potentially occurring at PHETS, SHIST, Alt. SHIST, and HTD.

Floral Species	Scientific Name	Status	Test Bed Potential Occurrence
Cory jointfir	*Ephedra coryi*	WSMR SOI	Alt. SHIST, HTD, PHETS, SHIST
Dagger thorn cholla	*Opuntia clavata*	WSMR SOI	PHETS, SHIST, Alt. SHIST
Gramagrass cactus	*Pediocactus papyracanthus*	WSMR SOI	PHETS, SHIST, Alt. SHIST
Lanceleaf beardtongue	*Penstemon ramosus*	WSMR SOI	HTD
Pineapple cactus	*Neolloydia intertexta*	WSMR SOI	PHETS, SHIST, Alt. SHIST
San Andres rock daisy	*Perityle staurophylla*	State Sensitive	HTD

SOI = Species of Interest

3.2.3 Fauna

WSMR contains many diverse habitats that support a variety of wildlife species. Major physiographic regions include the Jornada del Muerto Basin, the Tularosa Basin, the San Andres Mountains, and Oscura Mountains. The biodiversity of these areas is due, in part, to elevation, diversity of landforms, and variations in vegetation association types (U.S. Army, 1998). In regard to DTRA test beds, the ecological setting of each largely dictates the faunal communities that exist in the region.

Mammals. WSMR is home to many game and non-game mammal species. Seventy mammal species have been documented on WSMR (Burkett and Kamees, 1998). Large herbivores commonly found on WSMR include mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), and oryx (*Oryx gazella*). Predator species commonly found on WSMR include coyotes (*Canis latrans*), bobcats (*Lynx rufus*), mountain lions (*Felis concolor*) and badgers (*Taxidea taxus*). Small mammals occurring on WSMR include black-tailed jackrabbits (*Lepus californicus*), desert cottontails (*Sylvilagus auduboni*), and desert shrews (*Notiosorex crawfordi*). Rodents make up the most diverse order of mammals occurring on WSMR, consisting of five families: Sciuridae, Geomyidae, Heteromyidae, Muridae, and Erethizontidae (WSMR, 2001).

Oryx (*Oryx gazelle*) on WSMR (source: Walcoff Environmental, WSMR).

Twenty species of bats are known or expected to occur on WSMR (U.S. Army, 1998). Thirteen species representing two families, Vespertillionidae and Molossidae, have been documented on the range (Burkett and Kamees, 1998). Most of the bats in the area prefer to roost in caves and crevices, although some species would utilize manmade structures and a few are open nesting species preferring to roost in trees and other vegetation (Findley, 1987).

Major physiographic regions within WSMR include the Jornada del Muerto Basin, the Tularosa Basin, the San Andres Mountains, and Oscura Mountains. The biodiversity of these areas is due, in part, to elevation, diversity of landforms, and variations in vegetation association types.

Birds. Habitats within WSMR support nearly 300 documented avian species, many of which are seasonal or year-round residents (WSMR, 2001). WSMR has resident populations of raptors, game birds, and songbirds. Raptor species common on WSMR include red-tailed hawks (*Buteo jamaicensis*), northern harriers (*Circus cyaneus*), and prairie falcons (*Falco mexicanus*). Game birds found on WSMR include Gambel's quail (*Callipepla gambellii*), scaled quail (*Callipepla squamata*), white-winged dove (*Zenaida asiatica*) and mourning dove (*Zenaida macroura*). Songbirds common to WSMR include American robins (*Turdus migratorius*), pyrrhuloxia (*Cardinalis sinuatus*), and horned larks (*Eremophila alpestris*). Kamees and Burkett (1999) have compiled a comprehensive list of birds found on WSMR.

Herpetofauna. WSMR has a wide assortment of reptiles mostly comprised of snake and lizard species. Three families of snakes are represented on the range: Leptotyphlopidae (blind snakes), Colubridae, and Viperidae (vipers). Two species of turtles, ornate box turtles (*Terrepene ornata*) and yellow mud turtles (*Kinosternon flavenscens*), also inhabit the range.

Amphibian species are less abundant than reptiles. More common amphibian species include four species of Bufonidae (true toads) and three species of spadefoot toads (Pelobatidae). One species of salamander, the tiger salamander (*Ambystoma tigrinum*), occurs on WSMR (Burkett, 2000). This species can occur wherever suitable habitat, such as temporary rain pools and stock ponds, are available (Degenhardt et al., 1996).

Fish. The only fish species native to WSMR is the White Sands pupfish (*Cyprinidon tularosa*). This small fish is endemic to the Tularosa Basin, occurring in four separate habitats: Salt Creek, Malpais Spring, Mound Spring, and Lost River (Pittenger and Springer, 1999). Within its limited habitat, populations are often dense, but their

numbers can experience wide fluctuations due to natural climatic perturbations such as flood or drought. The White Sands pupfish is omnivorous, feeding mainly on aquatic insects and larvae, algae, and organic detritus (Propst and Pittenger, 1994).

Other fish species such as largemouth bass (*Micropterus salmoides*), mosquitofish (*Gambusia affinis*), goldfish (*Carassius auratus*), and sunfish (*Lepomis* spp.) have been introduced into springs, ponds and tanks (WSMR, 2001). None of these fish populations are located in the vicinity of DTRA operations.

Invertebrates. Invertebrate fauna of WSMR play a major role in such processes as pollination, soil aeration, decomposition, and seed dispersal. Invertebrates are also an important source of nutrition for many vertebrate species (WSMR, 2001). A complete inventory of invertebrate species for WSMR has not been documented. Common orders of insects found on WSMR include Coleoptera (beetles), Hemiptera (true bugs), Hymenoptera (ants, bees, and wasps), Lepidoptera (butterflies and moths), and Diptera (flies). Other common arthropod orders include Scholopenromorpha (centipedes), Pedipalpida (vinegaroons), Scorpionida (scorpions), and Araneida (spiders). Twenty-three species of land snails have been identified on WSMR, many of which occur in the San Andres Mountains (Sullivan and Smartt, 1995).

Previous Surveys for DTRA Activities. Many of the DTRA test areas have been previously surveyed for fauna occurrences. These surveys were required as part of the environmental documentation for each individual test bed as required by NEPA.

In support of the Programmatic Environmental Assessment for PHETS (U.S. Army, 2002b), faunal surveys were conducted at PHETS, SHIST and Alt. SHIST. These surveys were designed to determine presence/absence of faunal species and presence of threatened, endangered, or sensitive (TES) species. Three primary taxa were targeted for sampling: herpetofauna, birds, and mammals (including both small mammals and megafauna). All fauna encountered during the surveys were consistent with vegetation types common to the area and no TES species were observed.

Herpetofauna sampling was conducted for three consecutive days (15-17 May 2001) and four consecutive days (21-25 May 2001) prior to the monsoon season. Herpetofauna were surveyed using pitfall trapping, road cruising, and active daytime searches.

Winter bird surveys were conducted in December and January 2000 at PHETS, SHIST, and Alt. SHIST. Spring bird surveys were conducted at SHIST and Alt. SHIST in April 2001. Birds were surveyed using a point count method. Survey routes were conducted

along walking transects approximately 3,000 m (9,840 ft) in length with 3-minute stops at 100-meter intervals. Birds were identified aurally and/or visually.

Small mammal surveys were conducted in April and May 2001. Sherman live traps were used to capture small mammals for identification. A total of six transects were established: four at PHETS, and one each at SHIST and Alt. SHIST. Target trapping methods were adapted to sample slightly larger small mammal species. Wire traps (measuring 15 x 15 x 41 cm) were placed where signs (e.g., burrows, middens, and mounds) indicated small mammal activity in areas adjacent to small mammal transects. Incidental occurrences of mammals were also recorded. Active searches were conducted specifically for black-tail prairie dog (*Cynomys ludovicianus arizonensis*) occupation in the PHETS area. Megafauna presence was recorded incidentally while conducting the small mammal and other surveys.

The PHETS test beds were surveyed in the summer of 1994 in support of the Addendum to the Environmental Assessment of Long-term High Explosive Testing at White Sands Missile Range (Professional Systems Analysis, 1995). The purpose of this survey was to identify and characterize representative vegetation types and determine the presence or absence of Federal and State listed threatened, endangered, or candidate species. No systematic sampling of herpetofauna or mammals took place as part of this inventory, although some of both taxa were incidentally observed.

An ocular survey for birds was conducted along a 3-km route in the Phenomenology and Intermediate Test Beds and an 8-km route in the Large Test Bed. A total of 21 species were detected. No listed bird species were observed, however two of the species seen in 1994 have since been reclassified. The burrowing owl (*Athene cunicularia*) and the loggerhead shrike (*Lanius ludovicianus*) are now considered Federal species of concern.

No formal fauna survey has been conducted for the LB/TS area. The EA for the LB/TS listed animals expected to occur at this site. These species are typical to most habitats on WSMR in general (McMullan and Gould, 1988).

Faunal surveys were conducted in 2000 and 2001 in support of the Environmental Assessment for Hard Target Defeat Test bed (U.S. Army, 2002a). Biological survey personnel targeted four primary taxa for sampling: mammals, birds, herpetofauna, and terrestrial gastropods.

During the 2000-2001 surveys, small mammals were counted using both Sherman live traps and observational techniques. Bats were surveyed using an ultrasound bat detector,

mist netting, and active searching in abandoned mines, prospects, buildings, and other potential locations. Cliff faces were targeted for detection of roosting sites. Large mammals were recorded incidentally during this and other survey efforts.

Bird surveys were done at two separate times during different seasons, winter and summer. Surveys were done using a point-count method. All birds incidentally observed outside the designated search areas were added to the species list. Targeted observational searches for raptors were conducted in the cliff habitat in Capitol Peak.

Herpetofauna were surveyed in the HTD area using pitfall trapping and active day and night searches (U.S. Army, 2002a). A targeted search for terrestrial gastropods was conducted in talus slopes by flipping rocks at the margins of the slopes where leaf litter and talus intermix.

3.2.4 Threatened, Endangered, or Sensitive Fauna

Threatened, Endangered, or Sensitive (TES) animal species are protected under the Endangered Species Act of 1973 and the New Mexico Wildlife Conservation Act of 1978. A total of 25 faunal species having Federal or State status occur or potentially occur on WSMR (Appendix D). A list of TES faunal species with potential to occur in

Threatened, Endangered, or Sensitive (TES) animal species are protected under the Endangered Species Act of 1973 and the New Mexico Wildlife Conservation Act of 1978.

the vicinity of DTRA test beds is presented in Table 3-4. This list was developed from the U.S. Fish and Wildlife Service (USFWS) and New Mexico Department of Game and Fish (NMDGF) TES lists for the counties of Lincoln, Otero, Sierra, and Socorro, New Mexico. (USFWS, 2004; NMNHP, 2004).

Table 3-4. Listed TES Faunal Species Potentially Occurring at DTRA Test Beds.

Species	Scientific Name	Federal Status	NM Status	Location of Concern
American Peregrine Falcon	*Falco peregrinus anatum*		T	SHIST, Alt. SHIST, HTDT
Aplomado Falcon	*Falco femoralis septentrionalis*	E	E	PHETS, LB/TS
Baird's Sparrow	*Ammodramus bairdii*		T	PHETS, LB/TS
Gray Vireo	*Vireo vicinior*		T	PHETS, SHIST Alt. SHIST, HTDT
Lucifer Hummingbird	*Calothorax lucifer*		T	SHIST, Alt SHIST
Violet-crowned Hummingbird	*Amazalia violiceps*		T	SHIST, Alt. SHIST
Desert Bighorn Sheep	*Ovis canadensis mexicana*		E	Alt. SHIST, HTDT
Oscura Colorado Mountain	*Tamias quadrivittatus oscuraensis*		T	SHIST

Species	Scientific Name	Federal Status	NM Status	Location of Concern
Chipmunk				
Organ Mountain Colorado Chipmunk	*Tamias quadrivittatus australis*	SOC	T	Alt. SHIST, HTDT
Spotted Bat	*Euderma maculatum*		T	PHETS, SHIST, Alt. SHIST, HTDT

E=Endangered, T=Threatened, CW=Candidate with Warranted but Precluded determination, SOC=Species of concern

Mammals. The desert bighorn sheep (*Ovis canadensis mexicana*), an Endangered species for the State of New Mexico, is confined to steep and inaccessible areas of the San Andres Mountains. In November 2002, 51 desert bighorn sheep were introduced into the San Andres Mountains. Prior to the release the population had decreased to nine individuals due to a scabies outbreak and mountain lion predation (Morrow, 2003).

Bighorn sheep (source unknown).

The Oscura Mountains Colorado chipmunk (*Tamias quadrivittatus oscuraensis*), listed as threatened by the State, only occurs in the Oscura Mountains. Once considered a population of Organ Mountains Colorado chipmunk (*T. q. australis*), it has recently been described as a separate subspecies (NMDGF, 2000). Both subspecies are considered Threatened by the State of New Mexico. The Organ mountains Colorado chipmunk is also considered a species of concern by NMDGF.

The spotted bat (*Euderma maculatum*) is listed as threatened by the State of New Mexico (NMDGF, 2004) and is considered a “probable species” on WSMR (Burkett and Kamees, 1998). Spotted bats have been observed in a variety of habitats, from riparian and pinyon-juniper woodlands to ponderosa pine and spruce-fir forests (Findley, 1987). In New Mexico, the species has been collected from the lower Rio Grande Valley near Las Cruces (elevation 1,200 m [3,936 ft]) to near the peak of Mt. Taylor (elevation 3,230 m [10,594 ft]), but most records are in or near wooded areas (NMDGF, 1988). This species prefers to roost in rock crevices in cliff faces (Findley, 1987). In 1999, two spotted bats were captured on WSMR during a planning level survey. One spotted bat was captured at Mound Spring, approximately 13.6 km (5.5 mi) east of the Capitol Peak HTD test bed. Another was captured at Borrego Spring, approximately 26 km (16 mi) northeast of PHETS site in the WSMR Northern Extension. In addition, audible calls were detected at additional sites on WSMR (Chung-MacCoubrey, 2000).

Fish. Although not found on or close to DTRA test beds (Figure 3-8) (but potentially is within DTRA’s region of influence), the White Sands pupfish (*Cyprinidon tularosa*) is

listed as a State threatened species and a Federal species of concern. (Throughout this section, the term "species of concern" refers to a USFWS designation used for planning purposes only and connotes no listing status). These hardy fish are restricted to shallow, calm, brackish-to-saline waters such as Mound Springs, Malpais Springs, and Salt Creek in the Tularosa Basin. Listed faunal species that have possible suitable habitat in or around DTRA test beds areas are discussed below.

Birds. TES bird species that have been documented on WSMR include the northern aplomado falcon (*Falco femoralis septentrionalis*), American peregrine falcon (*Falco peregrinus anatu*m), bald eagle (*Haliaeetus leucocephalus*), Baird's sparrow (*Ammodramus bairdii*), and piping plover (*Charadrius melodus*).

The northern aplomado falcon, an endangered species on Federal and State lists, is found in grasslands and shrublands at lower elevations from approximately 853-1,676 m (2,800-5,500 ft) (Hubbard, 1978). Potential habitat for the aplomado falcon is shown in Figure 3-8. This falcon prefers open terrain with scattered trees and low ground cover with a good supply of suitable nesting platforms, particularly mesquite and yuccas (USFWS, 1987). WSMR represents the northern boundary of the historical range of the aplomado falcon. WS-ES and USFWS have classified two regions on WSMR as potentially suitable aplomado falcon habitat (WSMR, 1997). These are limited to desert grasslands in the lower Three Rivers drainage, and in the Jornada del Muerto basin (WSMR, 1997). The occurance of critical habitat for the aplomodo falcon has not been identified in the United States by the USFWS. Critical habitat is specific geographical areas designated by the USFWS on which are found those physical or biological features essential for the conservation of the species (USFWS, 2004).

A single transient aplomado falcon was sighted on WSMR at Rita Site and Black Site on two separate occasions in 1991 and 1992 (D. Holdermann, pers. comm., 2000). More recently, a juvenile aplomado falcon was observed near Stallion Range Center on 27 August 2005. This individual was also believed to be a transient (T. Griffin, pers comm., 2005). The population of the northern aplomado falcon in the region of the DTRA test beds has recently been down-listed (July 26, 2006) from Federally Endangered to an Experimental Nonessential Population under section 10 (j) of the Endangered Species Act of 1973 as amended. The geographic boundary of this population completely encompasses the entire boundaries of WSMR (USDOI, 2006).

The bald eagle, listed as threatened by both the U.S. Fish and Wildlife Service (USFWS) and New Mexico Department of Game and Fish (NMDGF), has been proposed for de-listing. This species is primarily water-oriented with the majority of the New Mexico

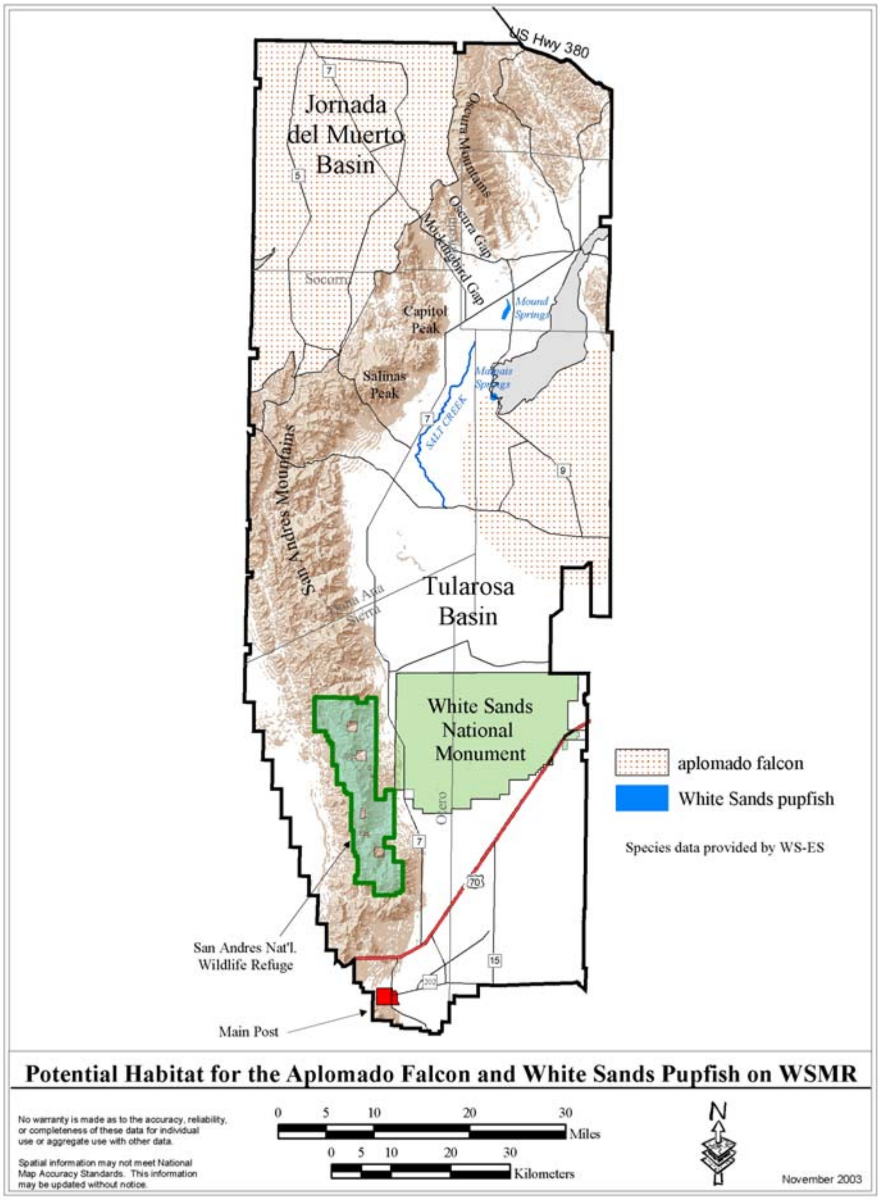


Figure 3-8. Potential habitat for the aplomado falcon and White Sands pupfish on WSMR.

populations found near streams and lakes. However, there are some "dry land" areas where these eagles frequent regularly. The bald eagle is described as a species passing through WSMR during migration (Kamees and Burkett, 1996).

The American peregrine falcon is listed as threatened by the State. This species breeds in mountainous areas and, in New Mexico, occurs mainly west of the eastern plains in migration (Hubbard, 1978). The peregrine falcon occurs on WSMR, mainly in the breeding months (March-August) (Kamees and Burkett, 1996). These falcons have not been found to breed on WSMR, but transient individuals have been seen on WSMR at two locations: in 1995, in the mouth of Texas Canyon in the Organ Mountains; and in 1994 about 2.1 km (1.3 mi) north of Malpais Springs on RR 9. There have also been several sightings on lands adjacent to WSMR (WSMR, 2001).

Baird’s sparrow is listed as threatened by the State. In New Mexico, it has been found in a variety of habitats, ranging from desert grasslands in the south to prairies in the northeast, and in mountain meadows. This sparrow occurs in the eastern plains and southern lowlands during migration, mainly in autumn and is considered rare to uncommon (Hubbard, 1978). Baird's sparrow occurs mainly in winter months (late October - February) at WSMR (Kamees and Burkett, 1996).

The piping plover is designated as Federal threatened and State endangered. This species migrates mainly through the Mississippi Valley and along the Atlantic Coast, and it winters primarily along the Atlantic and Gulf coasts from South Carolina to Texas. In New Mexico, this bird is a rare spring (April) migrant and has been reliably reported at Bosque del Apache National Wildlife Refuge (Socorro County). Piping plovers have only been reported in New Mexico on six occasions (NMDGF, 2000).

Herpetofauna. The mottled rock rattlesnake (*Crotalus lepidus lepidus*) is listed as threatened by the State; however none have been documented on WSMR (D. Burkett, pers. comm., 2002). Rock rattlesnakes occur between 1,200 – 2,600 m (3,937-5,249 ft) elevations in New Mexico and are most commonly found in steep, rugged mountainous areas or canyons. This species favors areas of boulders and rocks, including talus slopes (Degenhardt et al., 1996).

3.3 Cultural Resources

3.3.1 Cultural History of White Sands Missile Range

Evidence in the material record suggests continued prehistoric human occupation of the White Sands Missile Range (WSMR) region spanning approximately 11,000 years. As

the environment gradually became drier and more extreme, humans inhabiting the area adapted by changing food procurement and living strategies. These changes have been documented and divided into periods and phases (Table 3-5).

Table 3-5. Prehistoric Periods and Phases of the WSMR Region.

Period	Phase	From	To
Paleoindian		9,500 BC	6,000 BC
	Clovis	*9,500 BC*	*9,000 BC*
	Folsom	*9,000 BC*	*8,000 BC*
	Plano	*8,500 BC*	*6,000 BC*
Archaic		6,000 BC	AD 400
	Gardner Springs	*6,000 BC*	*4,300 BC*
	Keystone	*4,300 BC*	*2,600 BC*
	Fresnal	*2,600 BC*	*900 BC*
	Hueco	*900 BC*	*AD 400*
Formative		AD 400	AD 1450
	Mesilla	*AD 400*	*AD 1200*
	Doña Ana	*AD 1200*	*AD 1300*
	El Paso	*AD 1300*	*AD 1450*

Adapted from Kirkpatrick (2001) and MacNeish (1993).

Paleoindian Period (circa 9,500 BC to 6,000 BC). While there is some disagreement regarding the exact placement of this period in time, it is generally accepted that this initial age of human existence in the Southwest began between 10,000 and 12,000 years ago. This was a time of climatic change from wet to dry, and populations appeared to have adopted seasonal patterns of resource exploitation that followed the availability of food resources. Paleoindians were highly mobile people, with sedentarism occurring only during periods of resource abundance. Given the nature of their subsistence, ceramic wares, usually linked with a more sedentary lifestyle, are not associated with this period (Cordell, 1984).

The three phases of the Paleoindian period (Table 3-5) are defined based upon changes in lithic assemblages and projectile point styles. The Clovis phase is by far the least known and documented of the three, with marginal evidence occurring in the region. Folsom assemblages are considerably better known, with a slightly greater diversification in lithic technologies. The Plano phase is characterized by a more heterogeneous projectile point tradition, with projectile point styles emerging as a response to changes in key game species (Cordell, 1979).

Archaic Period (circa 6,000 BC to AD 400). The Archaic period can perhaps best be described as an extended age of transition. Environmental change during the Paleoindian period led to the extinction of the mammoth and the expulsion of bison from the region, with the remaining meat sources largely being rabbit, deer, and pronghorn. Large projectile points diagnostic of the Paleoindians disappeared from the material record as the need for more varied points arose from a shift in game size. As a result, smaller, more stylized points became diagnostic (MacNeish, 1993).

In response to the loss of big game, it is speculated that these humans adapted by relying more on the availability of plant foods (MacNeish, 1993). Evidence in the form of groundstone assemblages (and, to a much lower degree, basketry) is often found with Archaic sites (Doleman, 1997). The use of domesticated plants is thought to have been the catalyst for the start of a rudimentary type of horticulture, which later led to further specialization in cultivation during more recent period. Social organization continued at the band/family level, and sedentarism is thought to have become a more seasonal pattern following the growth of certain edible plant species.

MacNeish (1993) divided the Archaic into four phases (Table 3-5). These phase designations were based on trends toward sedentarism and increased specialization in plant use. The material record reflects these trends with the development and evolution of groundstone tools and the appearance of basketry by the Hueco phase.

Formative Period (circa AD 400 to 1450). During the Formative period there was a move away from hunting and gathering toward a more sedentary and agricultural-based subsistence (Lehmer, 1948). The development of ceramic technologies, along with major changes in architectural design, defines the three phases of the period (Table 3-6).

Table 3-6. Material Characteristics of Jornada Mogollon Phases

Phase	From	To	Ceramics	Architecture
Mesilla	*AD 400*	*AD 1200*	*El Paso Brown, Mimbres Black-on-White*	*Subsurface Pithouses*
Doña Ana	*AD 1200*	*AD 1300*	*El Paso Brown, Red-on-Brown, and Polychrome; Chupadero and Mimbres Black-on-White; Playas Red*	*Subsurface Pithouses* | | | *Above Ground Adobe Pueblos*
El Paso	*AD 1300*	*AD 1450*	*El Paso, Gila, and Ramos Polychrome; Chupadero and Mimbres Black-on-White*	*Above Ground Adobe Pueblos*

[1]Adapted from Kirkpatrick (2001) and U.S. Army (1998).

The Mesilla phase (circa AD 400 to 1200), which is the earliest phase of the Formative period, is distinguished by the appearance of brownware ceramics – otherwise referred to as Jornada and El Paso Brown – and an increased dependence upon agriculture. Intrusive ceramics such as Mimbres Black-on-White have been associated with sites in the Tularosa Basin. The initial part of the phase also marks the emergence of semi-permanent pithouse villages (Carmichael, 1986; U.S. Army, 1998).

According to Lehmer (1948), the Doña Ana phase (circa AD 1200 to 1300) represents a shift in distinguishing characteristics from the Mimbres to El Paso phases. Above ground adobe pueblos eventually replaced pithouse villages as the predominant form of architectural design. Ceramic styles evolved into a more varied and complex tradition, with some of the most notable local and intrusive types being El Paso Brown, El Paso Red-on-Brown, El Paso Polychrome, Chupadero and Mimbres Black-on-White, Three Rivers Red-on-Terracotta, and Playas Red (U.S. Army, 1998).

The El Paso phase (circa AD 1300 to 1450) is the final temporal classification in the Jornada Mogollon sequence of the Formative period. Adobe pueblos were situated primarily on low ridges and bluffs adjacent to reliable water sources. Agriculture may have intensified during this phase in response to population growth as suggested by Lehmer (1948). Many of the intrusive ceramics associated with this phase are indicative of a Casas Grandes influence, with their origins extending hundreds of miles to the south. The ceramic assemblage consisted of El Paso, Gila, and Ramos Polychromes, Chupadero and Mimbres Black-on-White, and Three Rivers Red-on-Terracotta (Carmichael, 1986).

The Rio Abajo, associated with the Anasazi culture of northwestern New Mexico, is another cultural sequence of the Formative period. The Rio Abajo underwent temporal changes in material culture in a pattern similar to that of the Jornada Mogollon. Adobe pueblos replaced pithouses, and painted ceramics supplanted more utilitarian brownwares. Artifactual evidence from the northern portion of the Tularosa Basin suggests a limited Rio Abajo influence in the region (U.S. Army, 1998).

Protohistoric Period (Circa AD 1450 to AD 1540). The temporal gap between Spanish contact in southern New Mexico and the end of the Formative is referred to as the Protohistoric period (WSMR, 2001). Spanish explorers who arrived during the late 16th century classified the Manso, Suma, and Jumano cultural groups. Despite the lack of adequate material evidence for the existence of these cultures, it is speculated that the Manso shared an ancestral link with the Jornada Mogollon (WSMR, 2001).

Historic Period (Circa AD 1540 to Present).

Colonization, Independence, and New Settlement: Beginning with the colonization of the region by the Spanish in the late 16th century, the Historic period underwent three major changes in political organization. Strong colonial ties with Spain for the first 300 years prompted the establishment of missions and the allocation of lands for non-indigenous use throughout what is now New Mexico. The only interruption in this three-century reign was the Pueblo Revolt of 1680, during which Spanish settlers and indigenous sympathizers were ousted from New Mexico and forced to flee to El Paso. This hiatus lasted until the Reconquest of 1692, when Spanish control was reasserted in northern New Mexico (Dutton, 1983).

By 1821, descendents of the original Spanish colonizers gained independence from Spain under the political entity of Mexico, which included modern-day New Mexico. New Mexico remained part of Mexico until 1846, when American troops invaded and subsequently took control of the region. The Gadsden Purchase of 1853 delineated the U.S.-Mexico boundary, which remains intact today (WSMR, 2001). The Homestead Act of 1862, which, under its provisions, allowed for private ownership of land, acted as a catalyst for further settlement of the Tularosa Basin. These new settlers grazed cattle on the vast, open rangeland of the basin for over six decades (U.S. Army, 1998).

The Cold War Era: World War II brought on an increasing need for weapons testing and development for the purpose of national defense. The sparsely populated desert of the Tularosa Basin was chosen by the U.S. military for the establishment of the Alamogordo Bombing Range in 1942, and the White Sands Proving Ground (WSPG) 1945 (U.S. Army, 1998; U.S. Army, 2002c). The first atomic bomb was detonated at Trinity Site within the boundaries of the Alamogordo Bombing Range; V-2 rocket development and testing took place on WSPG after World War II. On 9 August 1952, the bombing range was placed under the control of WSPG. The name of WSPG was officially changed to White Sands Missile Range on 1 May 1958 (U.S. Army, 2002c).

3.3.2 Legal Framework

National Historic Preservation Act/Section 106. Section 106 of the National Historic Preservation Act (NHPA) requires federal agencies to take into account the effect of any proposed undertaking on historic properties that are listed on or eligible for listing in the National Register. Section 106 studies provide the information necessary to satisfy legal requirements for environmental documents under the National Environmental Policy Act (NEPA). NEPA requires that Federal agencies integrate the NEPA process with other

environmental laws. Section 106 of the NHPA (16 U.S.C. 470f) requires that impacts on significant cultural resources, henceforth called historic properties, be taken into consideration in any Federal undertaking. "Historic property means any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places (National Register) maintained by the Secretary of the Interior. This term includes artifacts, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the National Register criteria" [36 CFR §800.16(1)].

Section 106 of the NHPA defines "historic property" as any prehistoric or historic district, site, building, structure or object included in, or eligible for inclusion in, the National Register of Historic Places.

National Register of Historic Places. The determination of impacts on historic properties first requires a determination of a site's eligibility under the criteria established for the National Register of Historic Places (36 CFR 60.4):

The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, association, and

(a) that are associated with events that have made a significant contribution to the broad patterns of our history; or

(b) that are associated with the lives of persons significant in our past; or

(c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(d) *that have yielded, or may be likely to yield, information important in prehistory or history.*

Among other criteria considerations, a property that has achieved significance within the last 50 years is not considered eligible to the National Register unless certain exceptional conditions are met, primarily being associated with an important historic event or context.

3.3.3 Archaeological Sites

Archaeological surveys have been conducted throughout areas of WSMR since the range was established. Figure 3-9 shows the overall distribution of archaeological surveys on WSMR, and general discussions of the archaeological context of the DTRA test beds are presented in the following sections.

LB/TS. According to the environmental assessment for LB/TS (McMullan and Gould, 1988), 29 prehistoric archaeological sites were recorded in the Stallion area in a 1986 survey. Described as large areas with low artifact densities, no sites were located within the LB/TS project fence line.

Within the Trinity National Historic Landmark are two National Register-listed sites. Trinity site was the test area for the first manmade nuclear detonation and McDonald Ranch House is a historic homestead that was used to assemble the bomb.

PHETS. The Trinity National Historic Landmark boundary overlaps much of the PHETS project area. Within the landmark are two National Register-listed sites: Trinity site and McDonald Ranch House. Trinity Site was the test area for the first manmade nuclear detonation. Notable components include Ground Zero, the location of the first nuclear bomb detonation in 1945, the base camp that housed scientists and the support team, four instrumentation bunkers, and three observation bunkers.

Trinity Site, the test area for the first manmade nuclear bomb detonation in 1945, has been a National Historic Landmark since 1975 (source: http://www.wsmr.army.mil/pao/TrinitySite/tpixind.htm#).

The site encompasses a total of approximately 14,736 hectare (ha) [36,413 acres (ac)]. Located approximately 3.7 km (2.3 mi) to the southeast of Trinity Site, McDonald Ranch House is a historic homestead that was used to assemble the bomb. Over a dozen test-specific archaeological surveys have been conducted in the PHETS area. One hundred thirty-six (136) archaeological sites have been recorded, both prehistoric and historic (U.S. Army, 2002b).

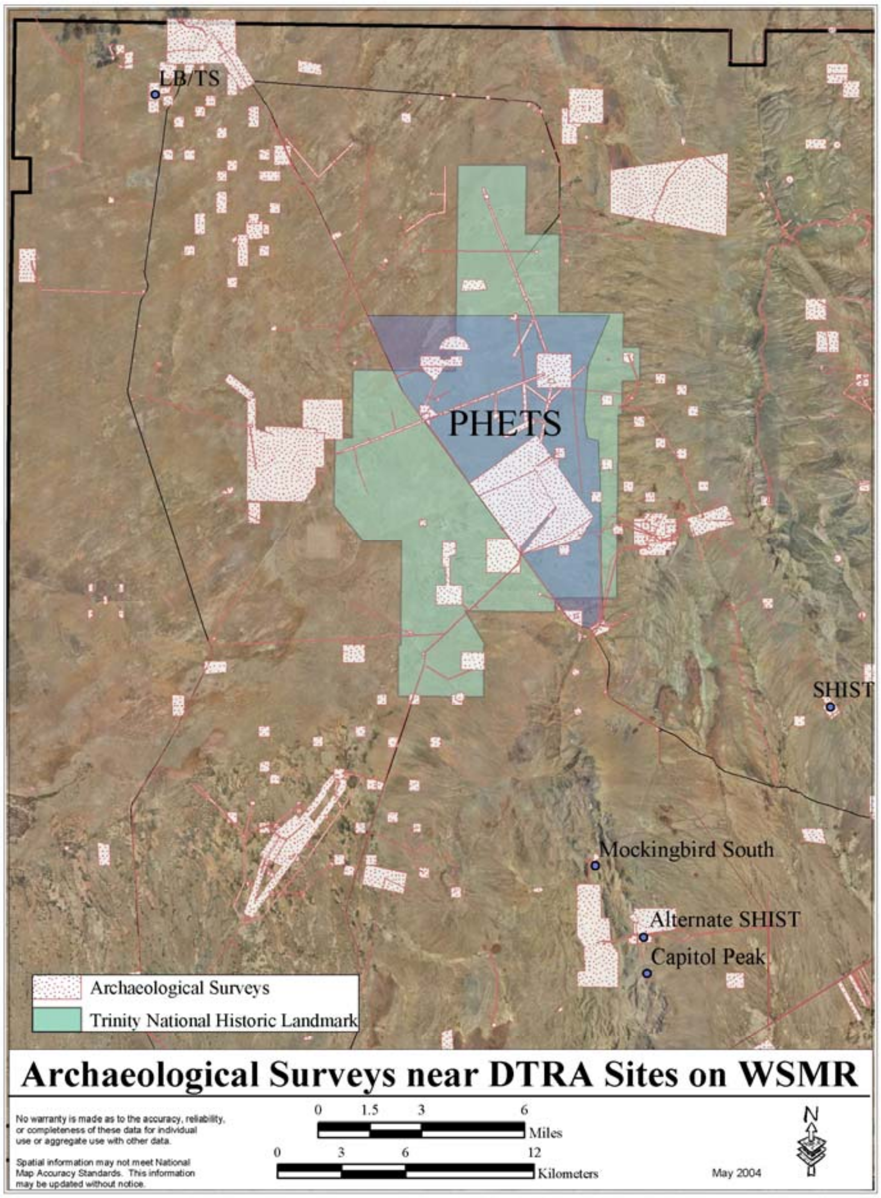


Figure 3-9. Map of archaeological surveys on WSMR.

SHIST. Geery and Hoyt (1977) and Webb (1993) conducted archaeological surveys of the original SHIST Site. A large Archaic period site was recorded in the SHIST area and is currently fenced for protection. Another smaller prehistoric site was identified immediately outside the original SHIST Site in 2000 and other archaeological sites have been documented in the vicinity, but none that are directly affected by activities at SHIST Site. The site was recently expanded to the north following completion of an archaeological survey (U.S. Army, 2002a).

Alt. SHIST. Several cultural resource surveys have been conducted in and around the area encompassing Alt. SHIST (Russell and Kirkpatrick, 1997; Phillips, 1996; Hart and Slensker, 1995; and Shields, 1990). A number of Archaic period sites were recorded that may contain information significant to the prehistory of the area. One large site with components dating from Paleoindian through the Jornada Mogollon was also recorded and tested to determine potential for buried resources. The site did contain subsurface artifacts and is considered to be eligible for NRHP (Russel and Kirkpatrick, 1997).

Mockingbird South. An archaeological survey conducted in May 2001 recorded two sites (LA 132538 and LA 132539) along the dirt road leading into Mockingbird South from Range Road 7 and re-visited a previously recorded site (LA 51474) in the valley floor of the proposed test bed.

Capitol Peak HTD. Previous archaeological projects in the Capitol Peak area have identified over 40 cultural resource sites (Russell and Kirkpatrick, 1997; Phillips, 1996; Webb, 1996; Hart and Slensker, 1995; Shields 1990, 1986; Laumbach, 1985). Most of these sites represent Archaic period occupation of the area, although some sites also exhibit Paleoindian and Formative period components. In addition, several historic period sites in the region have also been identified. An archaeological survey of 391 acres in the Capitol Peak project area was completed in May 2001 and four archaeological sites were recorded.

3.4 Present Land Use

3.4.1 Military Testing

The Main Range of WSMR (covering over 2.2 million acres) in combination with WSMR's Call-Up Areas (totaling approximately 1.6 million acres) provides for the largest single DoD land holding (U.S. Army, 1998). WSMR is managed by the U.S. Department of the Army and is operated to support DoD readiness programs including research, development, testing, and evaluation of weapons and space systems. The main

range is used for tests and evaluations of tri-service missile systems, high energy laser and directed energy systems, air defense fire-distribution systems, space systems, and surface-to-surface missile systems. Over 350 survey sites are partially developed, and many of these are used for measurement instrumentation during testing (U.S. Army, 2001).

As the largest single DoD landholding, WSMR is operated to support readiness programs including research, development, testing, and evaluation of weapons and space systems.

DTRA provides a number of testing areas and target types at WSMR for use by various DoD agencies, other U.S. government organizations, companies and allied government experimenters. Known initially as the Defense Nuclear Agency (DNA) and later as the Defense Special Weapons Agency (DSWA), DTRA and its predecessors have operated and maintained testing sites and related infrastructure at WSMR since 1976. Currently DTRA is using five sites on WSMR to conduct test activities: LB/TS, PHETS, SHIST, Alt. SHIST and Capital Peak HTD test bed.

Five DTRA areas are analyzed in the present land use section: LB/TS, PHETS, SHIST, Alt. SHIST, and Capital Peak HTD test bed.

The Large Blast Thermal Simulator (LB/TS) was built to provide experimental data for evaluations of military equipment subjected to intense blast overpressures and thermal radiation. This facility was approved for construction and use in December 1988. LB/TS became operational for testing in September 1993.

The Permanent High Explosive Test Site (PHETS) is a high explosive test site that has been used for non-nuclear tests since mid-1970s. PHETS is managed and maintained by DTRA. Development of PHETS has occurred through time with the evolution of more sophisticated military weaponry. Currently, there are five types of approved tests that are conducted at PHETS, including: static high explosive, rock penetration tests, collateral effects, anti-terrorism, and advanced weapon systems. Descriptions of each of these test types are provided in Section 2.1.

In 1993, a test that would generate seismic data from a simulated nuclear explosion contained in hard rock was approved for SHIST Site (U.S. Army, 1993). A Finding of No Significant Impact was documented in the *Environmental Assessment for Seismic Hardrock In Situ Source Test* (1993) for a test approved to occur in 1994. This test,

however, was ultimately not conducted, and SHIST was converted to a rock penetration test site. Tests at this and other DTRA sites are further described in Section 2.0.

Alt. SHIST was recognized as a possible test site in 1993, although SHIST was the preferred site based primarily on existing access routes. Alt. SHIST was eventually used as a test site for conducting earth-penetrating tests similar to those conducted at SHIST. Tests conducted at Alt. SHIST involve air-delivered and ground-based projectiles (Section 2.1).

The Capitol Peak HTD test bed area was approved for development and limited testing in January 2002 (U.S. Army, 2002a). Prior to that approval, the area was used as part of the overall military testing mission of WSMR. Construction of four tunnel targets on the flanks of Capitol Peak is essentially complete and would provide realistic targets for use by weapons testing customers. Air-delivered and ground-based testing has occurred at the HTD test beds (Section 2.1).

3.4.2 Recreation

WSMR is a military testing range, with limited recreational opportunities for the public. Public access to WSMR is generally restricted and granted by special permission only. A well-publicized event occurring twice a year within the PHETS boundaries is a tour of Trinity Site, the place where the first atomic bomb was detonated in 1945. The site is open to the public on the first Saturday in both April and October through two means of access: 1) a caravan with escort originating from the Tularosa Gate (on the eastern boundary of WSMR) proceeds to Trinity Site via Mockingbird Gap and, eventually, Range Road 13; 2) unescorted vehicles may enter the range through Stallion Gate (northern entrance to WSMR) and travel to the site via Range Road 20. The tours typically have optional side trips, including visiting McDonald Ranch House and viewing the regional vegetation; these activities are coordinated with other WSMR divisions through the Public Affairs Office. During the scheduling and planning of the tour, the Public Affairs Office would review security and safety issues.

Bataan Memorial Death March. WSMR's Missile Park is in the background (source: http://www.bataanmarch.com/).

Other scheduled events open to the public include several annual athletic challenges within the boundaries of WSMR. While most of these activities remain south of

Mockingbird Gap and away from DTRA test beds, road and mountain bike rides occur between Stallion Range Center and Trinity Site. The WSMR Public Affairs Office coordinates and/or assists with most of these events (WSMR, 2001).

Hunting is authorized during weekends, holidays, and range non-duty days, as long as it does not interfere with WSMR testing activities. All hunting activities on WSMR adhere to the rules and regulations put forth in the New Mexico Department of Game and Fish (NMDGF) proclamation, State and Federal laws, Army regulations, and range policies and regulations (WSMR, 2001). Parts of DTRA test beds are located within designated hunting zones as specified in the Memorandum for Garrison Commanders and Office Chiefs as follows: LB/TS (Zone 1); PHETS and SHIST (Zone 2); Capitol Peak HTD, Alt. SHIST, and Mockingbird South (Zone 5) (WSMR, 2003).

3.4.3 Areas Adjacent to WSMR

Although the main range is controlled and managed by WSMR, the following areas either on or adjacent to the main range, are managed independently of WSMR: White Sands Test Facility (WSTF), White Sands National Monument (WSNM), San Andres National Wildlife Refuge, Jornada Experimental Range (JER), and Trinity Site Natural Historic Landmark. These areas are managed in accordance with a Memorandum of Understanding (MOU) or cooperative agreement between each entity and the U.S. Department of the Army (U.S. Army, 1998).

Pronghorn Antelope (*Antilocapra americana*) (source unknown).

There are several adjacent protected areas that are managed independently of WSMR or through a cooperative agreement with WSMR.

On the southwest corner of WSMR, located on the western slope of the San Andres Mountains, is the National Aeronautics and Space Administration (NASA) White Sands Test Facility (WSTF), a part of Johnson Space Center in Houston, Texas. Bordering WSMR to the west is the JER and the Jornada Long Term Ecological Research Site operated by the U.S. Department of Agriculture. The JER shares a co-use area with WSMR where co-

White Sands National Monument at sunset (source: http://www.nps.gov/whsa/index.htm).

managed research projects are conducted by JER scientists, WSMR scientists, and National Wildlife Refuge wildlife biologists. (WSMR, 2001). White Sands National Monument (WSNM) is located in the southeast portion of WSMR; WSNM, Holloman Air Force Base (HAFB) and WSMR cooperatively manage local natural resources. The Trinity Site, which includes the McDonald Ranch House, is located within the WSMR boundary and is a designated National Historic Landmark. The Trinity Site is open for the public twice a year (Marlin, pers. com. 2004).

Sand Hill Cranes at Bosque del Apache National Wildlife Refuge (source: http://southwest.fws.gov/refuges/newmex/bosque/index.html).

Three national wildlife refuges, administered by the U.S. Fish and Wildlife Service (USFWS), are important partners for WSMR in ecoregional planning. The San Andres National Wildlife Refuge, located in the southern portion of the San Andres Mountains, provides important habitat for desert bighorn sheep (*Ovis canadensis mexicana*), a State-listed endangered species. The entire 57,215-acre Refuge lies within WSMR (USFWS, 2004). Bosque Del Apache National Wildlife Refuge is located near the northwest corner of WSMR and Sevilleta National Wildlife Refuge is located north of Socorro overlapping the North Extension Area.

The bulk of Bureau of Land Management (BLM) lands adjacent to WSMR come under the jurisdiction of the Las Cruces Field Office. Managed by the BLM, Aguirre Springs Recreation Area is located west of the Main Post on the eastern aspect of the Organ Mountains and Dripping Springs Preserve is located at the base of the Organ Mountains east of Las Cruces. Formerly part of the privately owned Cox Ranch, Dripping Springs is now a historical feature of the Organ Mountains Recreation Area. The Preserve abuts Fort Bliss lands on the east side of the Organ Mountains, but is little affected by the activities of WSMR despite its close proximity. Several private ranches and farms are also adjacent to or a short distance from WSMR.

The Valley of Fires Recreation Area, managed by the BLM Roswell Field Office, is located 3 miles from Carrizozo and contains one of the youngest lava fields in the continental U.S. (~10,000 years old); these lava flows extend into the eastern part of WSMR called the “Malpais.” The Mescalero Apache Reservation encompasses parts of the Sacramento and White mountains to the east of WSMR.

Memorandums of understanding (MOUs) negotiated between WSMR and these various management entities charge WSMR with the overall natural resources management on the installation including the enforcement of military, state, and federal laws and

regulations. These participating nonmilitary conservation agencies have the primary responsibility to provide technical assistance and advice WSMR on natural resources management (U.S. Army, 1983). More information on military testing programs and their effect on adjacent land areas is provided in the WSMR EIS (U.S. Army, 1998).

3.5 Airspace

The term airspace is described as the above-ground region used for transit of aerial vehicles. Airspace is a finite resource that can be defined spatially and temporally when describing its use for aviation purposes (USAF, 2003). The Federal Aviation Administration (FAA) is the federal regulative department that controls the skies over United States; under Public Law 85-725 of the Federal Aviation Act of 1958, airspace management and use are governed by FAA regulations resulting in the safe and efficient use of the nation's airspace. At WSMR, the FAA and WSMR have an agreement where both entities exchange control and management of the airspace.

3.5.1 WSMR Airspace

Types of airspace are categorized and defined by several means; at WSMR, there are several contiguous airspace areas which comprise a larger WSMR airspace complex. DTRA activities use certain airspace areas in this complex. The Cox Range Control Center (CRCC), located on Main Post, is delegated management and control of the airspace area in the region of WSMR, Holloman AFB, and Fort Bliss AFB when scheduled in support of their respective missions due to hazardous activities involved with military testing and training.

Under a share-use agreement with WSMR and the FAA, WSMR's Cox Range Control Center (CRCC) controls airspace over WSMR, Holloman AFB and Fort Bliss AFB. During times of testing activities, commercial and private aircraft are rerouted around WSMR's restricted airspace complex.

WSMR airspace is categorized as restricted airspace because of the potential periodic threat to aircraft traveling in this area. During the times of test activities, commercial, military, and private aircraft are rerouted around WSMR's restricted airspace complex. However, portions of the WSMR airspace complex are routinely returned to FAA control for use by civilian aircraft under a share-use agreement between WSMR and the FAA (Crnkovic, 1991; Brennan and Moya, pers. comm., 2004).

The airspace over the Jornada del Muerto Basin is frequently used for military training and is controlled by CRCC. Missions typically originate from Holloman AFB to the south and from Kirtland AFB to the north. Airspace use for DTRA-related tests must be coordinated through CRCC.

3.5.2 Main WSMR Airspace Complex

Fourteen restricted airspace areas form contiguous pieces of airspace which comprise the main WSMR airspace complex (Figure 3-10)**.** The CRCC controlled airspaces areas are scheduled for 1) research, development, testing and experimentation, 2) military training, and 3) civilian contract programs. Aircraft from Holloman AFB, Fort Bliss AFB, and other military installations are also permitted to operate in the WSMR airspace areas (U.S. Army, 1998). Civil or military aircraft must have proper authorization and approval from the scheduling office of the WSMR CRCC before entering WSMR airspace (Brennan & Moya, pers. com. 2004).

Cox Range Control Center controls 14 restricted airspace areas which form a contiguous piece of airspace over WSMR called the "WSMR airspace complex".

The major activities conducted in WSMR and the DTRA airspace areas include air-to-air, air-to-surface, surface-to-air, and surface-to-surface weapon system tests. Large areas of airspace are used as safety buffer zones for missile and rocket firings (USAF, 1998). Other activities include: the operation of aerial drone targets; towed aerial targets; UAVs; space probes; safety chase; aerial photography; fixed- and rotary-wing security patrols. Training activities in the WSMR airspace include NASA shuttle training aircraft, bomb delivery, Air Combat Command and Air National Guard air-to-air combat maneuvers, and other military exercises (USAF, 1998).

Airspace areas in and surrounding WSMR, including DTRA areas, are designated into different types including: Restricted Areas, Military Operations Areas (MOAs), Military Training Routes (MTRs), and Jet Routes (Brennan, pers. comm., 2004).

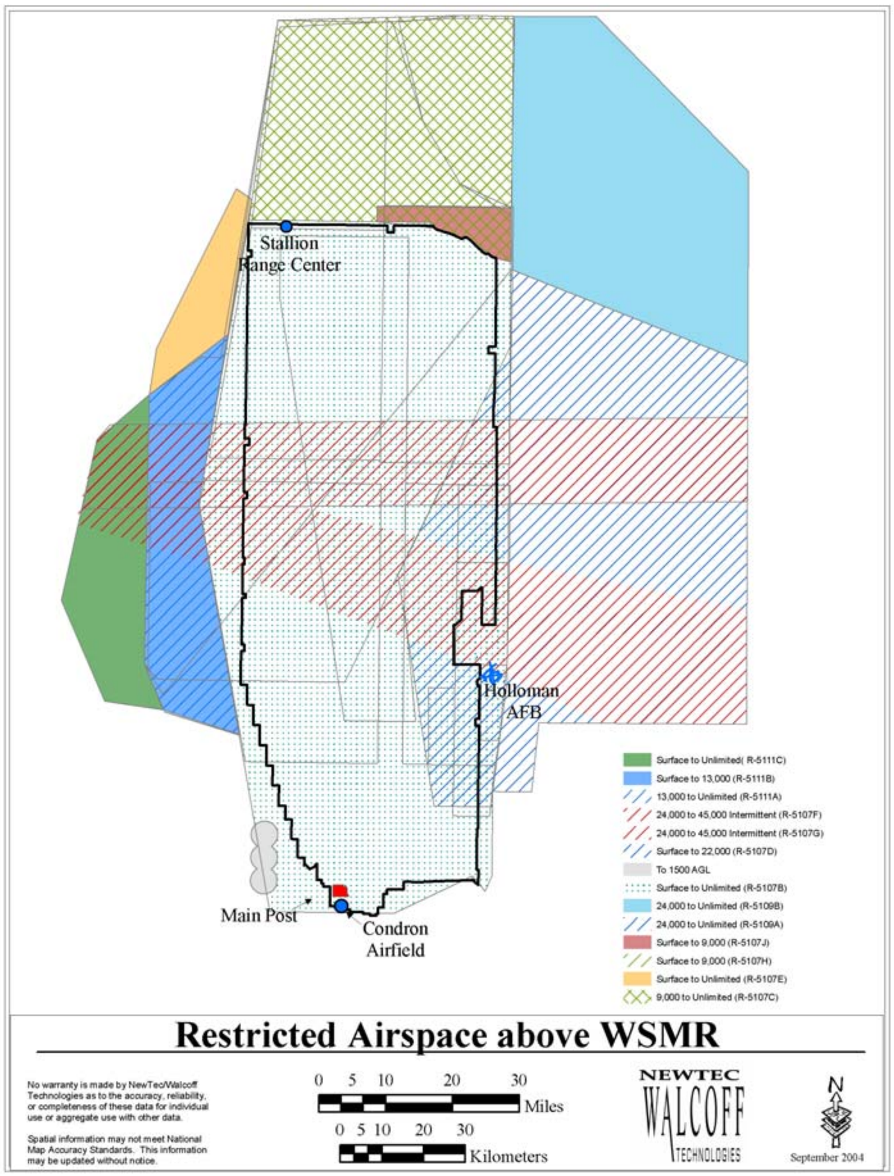


Figure 3-10. Map of restricted airspace above WSMR.

3.5.2.1 Restricted Areas

Restricted areas denote the existence of unusual, often invisible, hazards to aircraft such as artillery firing, aerial gunnery or guided missiles (USAF, 2003). Restricted areas are established around locations where hazardous activities such as bombing, gunnery, and artillery operations are conducted. Access to this airspace is limited to those aircraft participating in these activities when the airspace is active and designated or joint use by the FAA. Restricted airspace surrounds the Oscura and Red Rio Impact Areas on WSMR and Centennial Range in McGregor Range on Fort Bliss. These restricted airspaces extend from the surface to unlimited altitudes (USAF, 1998). Not all WSMR airspace is surface to unlimited, however; airspace is defined by altitudes and only activated as needed to lessen impacts to non-participating aircraft (Brennan, pers. comm., 2005).

3.5.2.2 Military Operations Areas

Military Operations Areas (MOAs) are established to separate non-hazardous military flight training from other instrument flight rules (IFR) traffic and to identify for visual flight rules (VFR) pilots where these operations are being conducted (USAF, 1998). MOAs are not restricted airspace; civilian and commercial aircraft can operate cautiously within these airspaces (Brennan pers. comm., 2004). MOAs consist of airspace defined by vertical and lateral limits. Air Traffic Control (ATC) can clear, reroute or restrict, nonparticipating IFR traffic through an MOA whenever the area is being used (USAF, 2003). Because military pilots need higher altitudes to conduct air combat maneuvers and intercepts, Air Traffic Control Assigned Airspace (ATCAA) is established above most MOAs to extend working altitudes for this training. ATC ensures separation between military aircraft and any non-participating IFR traffic being routed through the MOAs and ATCAA (USAF, 1998).

3.5.2.3 Military Training Routes

Military Training Routes (MTRs) are essentially aerial “highways” of varying dimensions (such as lengths, widths, and altitudes) and are used for flight tactics and navigation (USAF, 1998). MTRs are not restricted airspace; civilian and commercial aircraft can operate cautiously within these airspaces (Brennan pers. comm., 2004). MTRs, a joint venture by the FAA and the DoD, are mutually developed for use by the military for the purpose of conducting low-altitude, high-speed training. Generally, MTRs are established below 3048 m (10,000 ft) MSL for operations at speeds in excess of 463 km/h (288 mph) (USAF, 2003). The FAA states that it is a voluntary practice for pilots to “make every effort to fly not less than 610 m (2,000 ft) above the surface, weather permitting” over noise-sensitive areas such as protected areas (e.g. wildlife refuges) (FAA, 2004).

3.5.2.4 Jet Routes

There are two jet routes that cross the Restricted Areas complex above 5,486 m (18,000 ft) mean sea level (MSL). These two routes are normally unavailable within the Restricted Areas during daytime hours, Monday through Friday (USAF, 2003).

3.5.3 Scheduling

Airspace scheduling usage is an important factor in airspace management and air traffic control (USAF, 2003). At WSMR, any aircraft that has not been authorized and scheduled by the controlling agency are prohibited from entering the active controlled/restricted airspace areas. Once authorized and approved, these airspace areas, in most cases, can be scheduled for use from the surface to unlimited altitude 24 hours per day. However, during part(s) of each day, some of the WSMR controlled/restricted airspace areas may be returned to FAA control for use by civilian or other aircraft during times of non-DoD use. This intermittent shifting of airspace control over WSMR is permitted under a shared-use agreement between WSMR and the FAA (Crnkovic, 1991 and Brennan & Moya, pers. comm., 2004).

Due to competition for airspace at WSMR and surrounding facilities, all airspace activities are scheduled through the office of the Scheduling Chief at CRCC.

A priority scheduling system prescribes the use of WSMR airspace. Each authorized activity supported by WSMR is categorized as a range program; there are three priorities assigned according to the nature of these programs including National Priority, the highest priority, which requires written U.S. Army direction. Priority 1 is assigned to research and development testing and experimentation, guided-missile firings, and high-energy laser operations. Priority 2 is assigned to non-research and development testing and experimentation, guided-missile firings and high-energy laser operations. Priority 3 includes all other programs (U.S. Army, 1998).

3.5.4 Airstrips, Airbases and Airports

A major airstrip near the DTRA test beds is Stallion Army Airfield located approximately 19.3 km (12 mi) from the PHETS administration park near the range's northern boundary. There are various rotary- and fixed-wing landing areas on WSMR including White Sands Space Harbor (WSSH) which NASA maintains as a backup site for space shuttle landings. Some WSMR airfields and airstrips, however, may not meet various government agency standards (for example, in length, width and compaction) for take off and landing activities (Brennan, pers. comm., 2005).

Holloman Air Force Base (HAFB) (the Alamogordo Army Air Field until 1948) is a major air base for military training and is located adjacent to the southeast corner of WSMR. This facility operates three active runways and is home to the German Air Force and the 49th Fighter Wing that fly F-117A aircraft. Extensive training programs are conducted at Holloman AFB which utilizes a portion of the designated WSMR controlled airspace. Aerial training missions from the base frequently use the airspace in the northern part of WSMR.

3.5.4.1 Surrounding Airports

Proteus aircraft over Las Cruces International Airport (source: http://www1.dfrc.nasa.gov/Gallery/Photo/Proteus/index.html).

There are several nearby airports: El Paso International Airport in Texas and Albuquerque International Airport in New Mexico are designated as Class C airspace. Las Cruces International Airport in New Mexico is located approximately 10 miles west of Las Cruces and is home to the Physical Science Laboratory's (PSL) UAV Flight Test Facility. Several other airports are located near WSMR at Alamogordo-White Sands Regional Airport to the east of WSMR, Truth or Consequences Airports to the northwest of WSMR, Socorro Airport to the northwest of WSMR, Carrizozo Airport to the northeast of WSMR, and Sierra Blanca Regional Airport to the east of WSMR.

3.6 Air Quality

Air quality relates to the overall healthfulness of the air determined by the amounts and types of pollutants it contains. Air quality (and visibility over long distances) is affected by factors including topography, climate, soils, vegetation, and pollution sources within the area. The location and topography of WSMR generally promote conditions that do not concentrate manmade pollutants. The natural setting of the range, however, is conducive to generation of airborne dust during high winds.

The New Mexico Environment Department (NMED) and the United States Environmental Protection Agency (EPA) through Air Quality Control Regions (AQCR) regulate air quality of New Mexico. WSMR is situated mostly within AQCR 153, although the northern end (Socorro County) is in AQCR 156. Pollutants that are monitored using the AQCR include carbon monoxide, ozone, nitrogen dioxide, sulfur dioxide, respirable particulate matter, and lead. Additionally, there are two levels of National Ambient Air Quality Standards (NAAQS). The primary standards are defined to protect public health with a margin of safety, while the secondary are focused on public

welfare protecting economic and environmental values. WSMR is located in areas that are considered to be in attainment of NAAQS (WSMR, 2001).

New Mexico has equally strict air quality standards that include a more extensive pollutant list than the NAAQS (Table 3-7). Criteria pollutants must not exceed New Mexico standards to fulfill compliance requirements. New Mexico has also adopted a set of air quality control regulations that apply to stationary sources of air pollution such as generators, including a section designed to prevent significant deterioration of localized air quality in areas classified as 'in attainment' under NAAQS. Equipment covered by this section includes certain listed stationary sources that emit more than 100 ton/yr of any regulated pollutant, or other stationary sources that emit more than 250 ton/yr.

3.6.1 Airborne Dust

Airborne dust is a persistent problem throughout WSMR, including the DTRA test beds. Strong westerly winds are typical in the spring (March through early May) producing dust storms prior to the onset of the rainy season. Intact soils and vegetation generally promote better air quality; however, if vegetation is removed and soil exposed, wind erosion often leads to substantial amounts of airborne dust. Likewise, the arid to semi-arid climate in the region results in less plant cover and thus tends to exacerbate wind erosion and dust generation.

Airborne dust is a persistent problem throughout WSMR, including the DTRA test beds. PHETS has been listed as an area targeted for specific dust control measures and is currently following the Natural Events Action Plan for Dona Ana County.

Table 3-7. Federal and NM Air Quality Control Standards.

POLLUTANT	AVERAGING TIME	NATIONAL STANDARD (NAAQS)	NM STANDARD
Carbon monoxide (CO)	1-hour 8-hour	35 ppm 9 ppm	13.1 ppm 8.7 ppm
Ozone (O_3)	8-hour	0.08 ppm	none
Nitrogen dioxide (NO_2)	24-hour annual	none 0.05 ppm	0.10 ppm 0.05 ppm
Sulfur dioxide (SO_2)	3-hour 24-hour annual	0.50 ppm 0.14 ppm 0.03 ppm	none 0.10 ppm 0 02 ppm

Table 3-7 (Continued).

Respirable particulate matter (PM_{10})	24-hour annual	150 μg/m^3 50 μg/m^3	none none
Respirable particulate matter ($PM_{2.5}$)	24-hour annual	65 μg/m^3 15 μg/m^3	none none
Total suspended particulate (TSP) matter	24-hour annual	none none	150 μg/m^3 50 μg/m^3
Lead	quarterly	1.5 μg/m^3	none

ppm = parts per million, μg/m^3 = micrograms per cubic meter
Source: New Mexico Administrative Code, 1995; EPA, 1997b

PHETS has been listed as an area targeted for specific dust control measures as part of the WSMR Particulate Matter Control Report (WSMR, 2001). WSMR has signed a Memorandum of Agreement (U.S. Army, 2001) with the New Mexico Environment Department (NMED) and is currently following the Natural Events Action Plan (NEAP) for Doña Ana County (Doña Ana County ordinance 194-2000). Therefore, other than during a National Emergency, WSMR programs would follow dust control prevention methods listed within the NEAP that does not compromise the mission of the range.

3.6.2 Manmade Pollutant Sources

Manmade pollution sources occur throughout WSMR but are mainly concentrated in the Main Post region where activity levels are highest. The main continuous source of manmade air pollution on WSMR is from vehicle emissions, including automobiles, missiles, aircraft, and ground targets. Dust generated from vehicular traffic on dirt and gravel roads is a common problem everywhere on WSMR. Specific to the north part of the range, a concrete batch plant and a propane boiler at PHETS generate airborne particulate matter and hydrocarbon emissions that require permitting under Title V of the Clean Air Act (U.S. Army, 2002b). The concrete batch plant and the propane boiler are included in the WMRS Title V air quality permit.

3.7 Noise and Blast

Major sources of noise at WSMR include missile launches, sonic booms, ordnance explosions, low-altitude military jet traffic, aircraft drone overflights, gunfire, military helicopters, and general vehicle traffic (U.S. Army, 1998). Typical noise sources for DTRA activities include background noises from vehicles, aircrafts, and other equipment.

Intermittent noises from weapons tests include high explosive discharges, bomb impacts, and various munitions delivery systems.

Traffic along established roads and other human activity add to background noise levels in accessible areas of WSMR. The average automobile traveling at 50-100 kph (30-60 mph) produces 60-75 dBA at a distance of 15 m, which is considered representative of vehicle-generated noise throughout the area.

LB/TS. Noise would be generated when a blast/thermal test is executed. Airblast and noise would be transmitted from the shock tube. The airblast/noise pattern is directional and greatest in line with the opening of the shock tube which points south away from Stallion Range Center and towards open range. The area impacted by airblast and noise would be dependent on the magnitude of the test, and the meteorological conditions at the time of firing (McMullan and Gould, 1988).

PHETS. Noise sources at PHETS are associated with program activities including those related to test preparations, detonation of penetration weapons and static high explosive charges. Construction would sporadically increase noise levels, but would not be heard in areas accessible to the public. Audible noise from a test would be infrequent and of short duration. The effects of noise and blast from HE testing vary with charge size.

SHIST. Loud intermittent noise and airblast would occur when HE and inert air-delivered weapons are tested. Other sources of noise at SHIST are equipment used for recovery of inert earth-penetrating warheads, and from vehicles and on-site generators.

Alt. SHIST. Loud intermittent noise sources at Alt. SHIST include static in-ground HE tests, air-delivered bomb impacts, and Davis gun firings.

HTD. Intermittent noise would be generated during testing of various weapons systems and munitions at HTD. Tests would be conducted by deploying both live and inert munitions delivered by air, and static detonations requiring ground-placement of charges inside the tunnel targets and include warheads, and thermobaric explosives. (Thermobaric explosives contain an explosive mixture that produces extremely high temperatures and pressures.) Background noise at the Capitol Peak test beds is derived primarily from vehicle or aircraft traffic associated with military activities.

3.8 Radiation

Radiation comes from many sources on WSMR and at the DTRA test beds. Typical sources of radiation come from radar, electrical power lines, cellular phones, and the

sun's rays. There are many different types of radiation that have a range of energy forming an electromagnetic spectrum (EPA, 2004). This spectrum is part of the affected environment.

Ionizing radiation is any one of several types of particles and rays given off by radioactive material, high-voltage equipment, nuclear reactions, and the sun. Types of ionizing radiation normally important to human health are alpha particles, beta particles, x-rays, and gamma rays (ATSDR, 1999).

Typical sources of radiation come from radar, electrical power lines, cellular phones, and the sun's rays. There are many different types of radiation that have a range of energy forming an electromagnetic spectrum. Background ionizing radiation is generated from the decay of radioactive minerals in rocks (at WSMR and virtually everywhere) at the approximate rate of 55 milliroentgens (mrem) per year.

Exposure to low levels of ionizing radiation from the environment has not been shown to affect human health. Exposure to high doses of ionizing radiation can result in nausea, skin burns, hair loss, illness, birth defects, and death (ATSDR, 1999). High voltage radar equipment is a common source of x-rays on WSMR but proper shielding reduces this hazard to all site personnel.

Background ionizing radiation is generated from the decay of radioactive minerals in rocks (at WSMR and virtually everywhere) at the approximate rate of 55 milliroentgens (mrem) per year. Trinity Site, the location of the first atomic bomb detonation in 1945, is within PHETS and continues to produce low levels of ionizing radiation (approximately 0.5 mrem during a one-hour visit). This amount is similar to what a person would receive flying in a jet airliner for one hour (American Nuclear Society, 2005).

Non-ionizing radiation refers to lower energy electromagnetic radiation, mostly in microwave and thermal wavelengths. Potential sources of non-ionizing radiation include lasers and radars. Lasers emit high-intensity light and are used for tracking and sighting purposes. Radar units produce microwave (heat) radiation in addition to x-ray (ionizing) radiation. The regulatory limit for hazardous human exposure is expressed by power density (mW/cm^2). It can be as low as 1 mW/cm^2 or as high as 10 mW/cm^2, depending on the frequency.

Sources of ionizing radiation previously used in program activities include instrumentation fielded for large-scale explosive testing and the testing of chemical agent

detectors. Sources of non-ionizing radiation previously used by DTRA activities include laser guidance and tracking systems, radar guidance and tracking systems, site illumination, communication, and electro-optical countermeasures.

Radiation safety issues are the responsibility of the WSMR Environment and Safety Directorate, Radiation Protection Division, which ensures compliance of rules and regulations outlined by the U.S. Nuclear Regulatory Commission and Army Regulation 11-9 (1999). These regulations focus on establishing policies and procedures for the use, licensing, disposal, transportation, safety design, and inventory control of ionizing and non-ionizing radiation sources. Radiation exposure standards, dosimetry (measurements of radiation doses) and accident reporting instructions are also addressed. For a more detailed description of radiation sources on WSMR refer to the WSMR RW-EIS (U.S. Army, 1998).

3.9 Hazardous Materials and Hazardous Waste

A hazardous material is any substance or chemical that exhibits either a physical or health hazard (29 CFR 1910.1200). A physically hazardous material has been shown through scientifically valid evidence that it is a combustible liquid, compressed gas, explosive, flammable substance, organic peroxide, oxidizer, pyrophoric, or is unstable (reactive).

Health hazard means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes.

Hazardous waste is any material listed in 40 CFR 261 Subpart D, or any material possessing any of the hazardous characteristics of toxicity, corrosivity, ignitability, and/or reactivity as defined in 40 CFR 261 Subpart C, or any material contaminated by or mixed with any of the materials described in 40 CFR 261.3.

Hazardous wastes produced by DTRA activities include a variety of liquid, solid and gaseous wastes. The Federal Resource Conservation and Recovery Act (Resource Conservation and Recovery Act, 1976) and the New Mexico Hazardous Waste Act (1985) govern the generation, recovery, storage and disposal of hazardous wastes.

Guidelines for the management and disposal of hazardous wastes generated by DTRA on WSMR is provided in WSMR Regulation 200-1.

A hazardous material is any substance or chemical that exhibits either a physical or health hazard (29 CFR 1910.1200). Hazardous waste is any material listed in 40 CFR 261 Subpart D, or any material possessing any of the hazardous characteristics of toxicity, corrosivity, ignitability, and/or reactivity as defined in 40 CFR 261 Subpart C, or any material contaminated by or mixed with any of the materials described in 40 CFR 261.3.

WSMR has developed an Environmental Disaster Plan as part of the White Sands Missile Range Disaster Control Plan to prevent and/or control (i.e., minimize the impact) accidental discharges of oil and hazardous substances and includes all actions taken before, during, and after the spill event to reduce the probability of damage, minimize its effects and initiate recovery (WSMR, 1995).

LB/TS. Operation of LB/TS should produce no hazardous waste. Sanitary sewage would be contained in an approved septic system which would periodically be emptied and disposed at an approved sewage treatment facility. Alumina dust discharged into the air is classified as simple dust and no fuels are or would be burned at the facility. The liquid nitrogen facility does not and would not produce hazardous by-products. Explosive charges are and would be used to rupture the diaphragms. No hazardous gasses, liquids, or solids would be used during testing. There is a satellite accumulation point (SAP) on site for containment of waste and recyclable petroleum, oils, and lubricants (POLs) generated by facility maintenance.

PHETS. Hazardous materials at PHETS include high explosives (HE), chemical and biological materials, construction products, and POLs. The type and degree of hazard for these materials can be found in Appendix E. Waste products from DTRA that could potentially be defined as hazardous (e.g., spent or excess test materials, paints, glues, and POL products) would be analyzed for such determination. If the product is deemed hazardous it is and would be handled in accordance with WSMR Regulation 200-1. There is a SAP area in the PHETS Administration Park for collection of small amounts of POL waste. Non-hazardous waste is and will be handled as solid waste or non-regulated waste.

SAP in the PHETS Administration Park source: Walcoff Environmental, WSMR).

SHIST and Alt. SHIST. No hazardous or toxic materials would be stored at SHIST or Alt. SHIST. Wastes potentially occurring at these sites include POL products from vehicles and equipment that are and would be managed of at the PHETS SAP site.

HTD. Hazardous wastes produced by DTRA activities at HTD test beds include a variety of liquid, solid, and gaseous wastes. Petroleum, oils, and lubricants (POLs) are the most widely used hazardous materials. Other products containing hazardous materials include batteries and cleaning solvents. Presently there is a SAP set up at HTD to pick up POL materials generated on site.

3.10 Human Health and Safety

General health and safety protocols for DTRA areas and facilities are addressed in various Federal, State, and WSMR guidelines, rules and regulations. Two comprehensive programs addressing these issues are Army Test and Evaluation Command (TECOM) Regulation 385-1 (U.S. Army, 2000c) and WSMR Regulation 385-18 (WSMR, 2000c). Detailed standard operating procedures (SOPs) have been established to fulfill health and safety requirements. The Command Safety Policy may also be viewed on the WSMR home web page (WSMR, 2003).

Two comprehensive programs addressing general health and safety protocols are Army Test and Evaluation Committee Regulation 385-1 and WSMR Regulations 385-18.

The White Sands Missile Range Disaster Control Plan (WSMR DCP) had been published in compliance with AMC Regulation 500-1 and supports the requirements of the TECOM Disaster Control Plan and the Fifth U.S. Army Natural Disaster Plan. The WSMR DCP is a continuing plan and sets forth policy, guidance, and requirements for the development and publication of implementing disaster plans (WSMR, 1995).

WSMR Flight Safety has the authority to terminate flight tests to protect personnel and equipment. Flight Safety is required to approve all flight tests, based on a comprehensive review of safety factors, risk analysis, and relevant SOPs.

Exposure to noise can be a public health hazard, causing hearing impairment and undue psychological stress. Extreme noise environments include loud impulse noise events (where people are subjected to sudden loud noise, such as a closed-room detonation), or high noise levels over extended periods of time (such as from a riveting machine or

pneumatic hammer operations). The loud impulsive events can especially have a severe effect on auditory capabilities and the health of the ear.

WSMR activities require adherence to the Occupational Safety and Health Administration (OSHA) Hearing Conservation Standard (29 CFR 1910.95), which protects workers from potentially hazardous occupational noise exposures. OSHA regulations establish a maximum noise level of 90 dBA for a continuous 8-hr exposure during a working day, and higher sound levels for shorter exposure times. Army regulations require that hearing protection be used when noise levels are greater than 85 dBA. Table 3-8 lists OSHA noise level exposure limits.

Table 3-8 OSHA Permissible Noise Exposure Limits.

NOISE LEVEL (dBA)	DURATION (hr/day)
90	8
92	6
95	4
97	3
100	2
102	1-1.5
105	1
110	0.5
115	≤0.25

Source: OSHA Standard 1910.95

Additional potential health and safety concerns for workers on WSMR and in the DTRA areas include exposure to hazardous materials, exposure to explosive devices, unexploded ordnance (UXO). All personnel involved in testing activities are required by WSMR to receive UXO training. UXO training videos can be viewed at the WSMR home web page (http://www.wsmr.army.mil/visitors/uxo.html).

Dehydration and heat stress are potential concerns, given the generally high temperatures in the region. Moreover, excessive exposure to the ultraviolet rays of the sun can result in sunburn and repeated exposure may produce skin damage and cause skin cancer.

There is also a potential for contact with venomous snakes, insects, and thorny/spiny vegetation. Hantavirus Pulmonary Syndrome (HPS) may occur on WSMR, which causes disease in humans through contact with urine or droppings of deer mice (*Peromyscus*

maniculatus) and other rodents. Rodents may nest in buildings and vehicles, creating an HPS hazard.

West Nile virus, transmitted to humans by infected mosquitoes has also been detected on WSMR. On WSMR, mosquitoes may concentrate in areas such as wildlife watering ponds and springs, standing bodies of water, sewage outflows or water collecting in barrels (Rodriguez, 2004).

3.11 Socioeconomics and Infrastructure

3.11.1 Introduction

Socioeconomics consist of the basic attributes and resources associated with the human environment, especially population and economic activity. Economic activity typically encompasses employment, personal income, and industrial growth. Impacts on these fundamental socioeconomic components influence other issues such as housing availability and provision of public services.

Socioeconomic data herein are presented at the county, state, and national level to analyze baseline socioeconomic conditions in the context of state, regional, and national trends. Data have been collected from (U.S. Census Bureau, 2004).

In 1994, EO 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations* (EO 12898, 59 Federal Register 7629 [section 1-10]), was issued to focus attention of federal agencies on human health and environmental conditions in minority and low-income communities and to ensure that disproportionately high and adverse human health of environmental effects on these communities are identified and addressed. Analysis would focus on the distribution of race and income in the areas potentially affected by implementing the proposed action.

EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, commonly referred to as "Environmental Justice for Children," states that each federal agency:

> "shall make it a high priority to identify and assess environmental health risks that may disproportionately affect children" and

> "shall ensure its policies, programs, activities and standards address disproportionate risks to children that result from environmental health risks or safety risks"

This EO primarily focuses on the noise environment around public schools. Analysis for this document would focus on the economic effects in the area as a result of the proposed DTRA activities.

3.11.2 Socioeconomics

The region of influence (ROI) is defined as the area in which the principal effects arising from implementation of the proposed action or an identified alternative are likely to occur. The proposed action and alternatives would directly affect areas dedicated to military testing on the northern portion of WSMR including surrounding communities in Doña Ana, Lincoln, Otero, Sierra, and Socorro counties in New Mexico. Primary socioeconomic activities in these counties include local industry, agriculture, and local, state, and federal government employment. Other minor activities that contribute to the economy include recreation activities such as large game hunting and tourism. These counties have shown increases in population and full- and part-time employment through recent years. WSMR directly commits approximately $1,000,000/day into the economy of the region including monies from salary and local contract dollars (WSMR Public Relations Website 2004). Socioeconomic data on Lincoln, Sierra, and Socorro counties (where DTRA test beds are located) are provided in Table 3-9.

Table 3-9. Selected Socioeconomic Data for NM Counties with DTRA Test Beds.

	Population in 2003, est.	Population per sq. mi., 2000, est.	Housing units in 2002	Median value of owner-occupied housing units in 2000	Median household income in 1999
Lincoln County	20,814	4.0	15,787	$108,400	$33,886
Sierra County	13,125	3.2	8,982	$77,800	$24,152
Socorro County	18,178	2.7	8,056	$80,900	$23,439
New Mexico	1,874,614	15.0	805,293	$108,100	$34,133
U.S.A.	290,809,777	79.6	119,302,132	$119,600	$41,994

Source: http://quickfacts.census.gov/qfd/states/35000.html

The dominant economic force in the region is the Federal government. Civilian, military and contractor employment statistics from 2002 (the most recent information available) are displayed in Table 3-10. WSMR employees live in the following areas: El Paso area (17%), Las Cruces area (56%), Alamogordo area (9%), WSMR proper (12%), and other

areas (6%). Most personnel supporting DTRA operations are employed as government or contract workers and live in local communities near DTRA test facilities located on the north part of WSMR. Military personnel supporting DTRA activities do not live near the DTRA test facilities but are TDY from Kirtland Air Force Base.

From the annual employee and payroll statistics, DTRA activities comprise .009% of employee strength and .005% of payroll in comparison to WSMR-wide employee and payroll statistics. All DTRA employees noted in these statistics live in local areas nearest to WSMR (Fraher, pers. comm., 2004).

Table 3-10. Annual Employment Statistics on WSMR Compared to DTRA.

	WSMR Employee Strength[1]	WSMR Payroll/Salaries[1]	DTRA Employee Strength[2]	DTRA Payroll/Salaries[2]
Civilian	2,553	$144,319,451	3	$156,000
Military	508	$10,901,897	0	$0
Contractor	3,150	$382,723,195	51	$2,610,400
Totals	6,211	$537,944,543	54	$2,766,400

1. WSMR, 2004. http://www.wsmr.army.mil/pao/FactSheets/stat02.htm
2. Fraher, pers. comm. 2004

3.11.3 Utilities

Electricity is provided to WSMR from several commercial sources, with El Paso Electric Company supplying 92% of the 92,121 MWh consumed during the 1999 fiscal year. The local power grid connects many frequently used sites across WSMR. Approximately 300 portable diesel generators, with an output from 10-700 kVA, are provided by WSMR to supply power at remote sites. The Information Operation Directorate is responsible for communication support to WSMR, including distribution, maintenance, and scheduling. Off-range telephone services are provided by Qwest Communications. Cellular phones and/or radios are required for personnel traveling north of U.S. Highway 70 on WSMR.

The PHETS Administrative Park is served for electricity, water, and heating; LB/TS, SHIST, Alt. SHIST, and HTD are not. Water for PHETS is obtained from the Stallion Range Center water system and delivered to a storage tank at the Administrative Park via tank truck. Many of the bunkers and support buildings on the PHETS test beds are hard-wired for power. Heating is provided through refillable propane tanks.

3.11.4 Transportation and Traffic Circulation

WSMR is bounded by U.S. Highway 380 to the north and U.S. Highway 54 to the east. U.S. Highway 70 crosses the southern portion of WSMR. No major access points exist

along the western boundary of WSMR. An agreement with the State of New Mexico allows WSMR to establish off-range roadblocks on U.S. Highways 70 and 380 as a safety precaution during missile tests. Under the agreement, roadblocks may last no longer than 1 hr 15 minutes. U.S. Highway 70 is subject to an average of one roadblock per day, while U.S. Highway 380 experiences approximately one roadblock per month (U.S. Army, 1998).

An extensive road network connects most areas within WSMR, with the exception of less accessible areas in the San Andres and Oscura mountains. LB/TS is adjacent to Range Road 5 near Stallion Range Center and is easily accessible. Range Road 7 provides access to PHETS, and an extensive internal network of roads both exists throughout the area. The size, surface, and condition of these roads vary; range roads 7, 20, and 13 are paved two-lane roads, and others are gravel or dirt.

SHIST is a relatively isolated site and admittance is usually through the Aerial Cable Range. Access to HTD test beds at Capitol Peak and Alt. SHIST is provided through dirt and gravel roads intersecting Range Road 7.

3.12 Environmental Justice

Environmental justice is the fair treatment and meaningful involvementof all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Environmental justice is achieved when everyone, regardless of race, culture, or income, enjoys the same degree of protection from environmental and health hazards and equal access to the decision-making process to have a healthy environment in which to live, learn, and work (U.S. EPA, 2004).

Two EOs deal specifically with environmental justice. EO 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations,* focuses attention of federal agencies on human health and environmental conditions in minority and low-income communities. EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks,* focuses on the noise environment around public schools.

The purpose of EO 12898 is to avoid the disproportionate placement of adverse environmental, economic, social, or health effects from Federal actions and policies on minority and low-income populations. In March 1995, the DoD issued the *Department of Defense Strategy on Environmental Justice,* which describes a strategy to meet the intent

of the Executive Order which would minimize adverse effects on human health and the environment of minority and low-income populations while carrying out its defense mission. A key point in this strategy plan is for DoD to use NEPA as the primary mechanism to implement the provisions of the Executive Order. Executive Order 13045 further recognizes and directs each Federal agency to ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks (U.S. Army COE, 1998).

The *Guidance for Addressing Environmental Justice* under NEPA (1997) for identifying minority and low-income population includes:

- Identification or minority populations where either

  The minority population of the affected area exceeds 50%

  The minority population percentage of the affected area is meaningfully greater than the minority population percentages in the general population

- Identification of low-income populations using annual poverty threshold statistics from the Bureau of the Census Population Reports.

The area of potential environmental justice issues within the ROI of this document would include the following counties where DTRA test beds are located: Lincoln, Sierra and Socorro. Socioeconomic indicators specifically dealing with environmental justice criteria (e.g. poverty, minority populations) for the major towns/city within the specified counties are analyzed in Table 3-11.

Based on the information from the U.S. Bureau of the Census, the minority population compared to total population within the surrounding areas of DTRA - using the four main city/town./block group information provided in the table – averages 49.9% for Hispanics of any race and 21.5% for "other" minority groups as described above (which include a percentage of Hispanics). These data indicate that the proportion of the minority population in the ROI could be considered as meaningfully greater than the minority population percentage in the general population.

Using the same four main areas of consideration, the percentage of the population in poverty within the ROI averaged 27.4% as compared to the state's 18.4%. These data indicate that the proportion of the population in poverty within the ROI could be

Table 3-11. Minority and Poverty Populations Statistics in ROI Reported in 2000.

Socioeconomic Indicators	Socorro City	San Antonio Block Group[4]	Carrizozo Town	Truth or Consequences Town	The State of New Mexico
Total population	8,877	1,674	1,036	7,289	1,819,046
Minority population percent, Hispanic[1] of any race	54.5	64.4	53.5	27.4	42.1
Minority population percent, "Other"[2]	33.8	12.4	25.2	14.8	33.2
Population in poverty[3]	2,730	468	269	1,620	328,933
Percent in poverty	32.3	27.4	26.8	23.2	18.4

Source: U.S. Bureau of the Census Web site http://www.census.gov/ and Bureau's Denver Regional Office
[1] "Hispanic" refers to Hispanic or Latino populations "of any race". The statistics reported in this table do not resemble an accurate percentage of actual Hispanic/Latino population compared to the total population of the area due to the following reasons: According to the U.S. Bureau of the Census on how people report their race, "People of Hispanic origin may be of any race and should answer the question on race by marking one or more race categories shown on the questionnaire, including White, Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, and Some Other Race. Hispanics are asked to indicate their origin in the question on Hispanic origin, not in the question on race, because in the federal statistical system ethnic origin is considered to be a separate concept from race."
[2] "Other" refers to Black or African American, Asian, Native American or Alaska Native, Hispanic, or another non-White minority race.
[3] "Population in poverty" refers to individuals living below the U.S. Bureau of the Census' definition of poverty level.
[4] Data for San Antonio, as it is not incorporated, was determined from the Regional Office of the Bureau of the Census. Data for the San Antonio area was derived from a "block group", a term used by the Bureau to describe a set of information in a geographical area. A block group contains socioeconomic data in the geographic area.

considered as meaningfully greater than the population of poverty in the general population.

Minority and low-income population are believed to exist within the ROI of this document. Therefore, an impact analysis needs to be conducted for this EIS in Section 4.12 to determine whether there is a potential for disproportionately high and adverse effects from the proposed action and alternatives.

4.0 ENVIRONMENTAL AND SOCIOECONOMIC CONSEQUENCES

An analysis of the potential environmental consequences that could result from implementing the proposed action and alternatives is presented in this section of the PEIS.

An environmental impact is a modification in the status of the environment as it presently exists, or as it is anticipated to exist in the future, as a result of the proposed action.

The environment is defined to include the natural and physical circumstances that influence the growth, development, and survival of organisms; as well as, the complex of social and cultural conditions affecting the nature of an individual or community. Environmental impacts can:

- Be adverse or beneficial
- Occur directly as a result of the action or indirectly as a secondary result. Direct impacts are caused by, and occur at the same time and place, as a specific action. Indirect impacts are reasonably foreseeable and may be attributable to a particular action, but they occur later in time or farther removed in distance from the action than a direct impact.
- Be long-term (greater than 10 years) or short-term (less than 10 years) in duration.
- Be of small magnitude with negligible change. An identifiable change that does not constitute a substantially adverse impact on the environment is a non-significant impact.
- Be an identifiable major adverse change to the environment. These impacts are known as significant impacts. Significant impacts are defined by their context and intensity. Generally, impacts are identified within the context of the project area, and the extent these impacts are perceptible beyond the project area. Intensity relates to the magnitude of the impact on environmental resources and the amount of controversy or risk.
- Be an impact that violates a law or regulation imposed for the protection of the environment would be considered significant.

Significant impacts are those that cause major adverse change to the environment. They are determined by their context and intensity.

Impacts are presented in the same order of environmental resources and topics presented in Section 3.0, Affected Environment. Environmental consequences sub-sections in this section include:

- Physical Resources
- Biological Resources
- Cultural Resources
- Present Land Use
- Air Space
- Air Quality
- Noise and Blast
- Radiation
- Hazardous Waste
- Human Health and Safety
- Socioeconomics, and Infrastructure
- Environmental Justice

Factors used to evaluate context and intensity for each environmental resource include:

- Resource sensitivity, or the probable response of a particular resource to an action
- Resource quality, or the present condition of the resource potentially affected
- Resource quantity, or the amount of the resource potentially affected
- Duration of impact, or the time over which the resources would be affected

Where quantitative measurements are not possible or readily available, qualitative criteria are used based on agency guidelines and professional evaluations.

4.1 Physical Resources

This sub-section analyzes the potential impacts of the proposed action and alternative two to the physical resources at WSMR. Mitigation measures that could be implemented to reduce any adverse impacts are presented. An overview of the present condition of the physical resources of WSMR was presented in Section 3.0, Affected Environment.

4.1.1 Impacts to Location and Topography

Potential impacts to location and topography would be considered significant if the proposed action, alternative two, or the no action alternative were to drastically change the contour of the land surface or change the location of testing sites.

4.1.1.1 Impacts of the Proposed Action

Under the proposed action, the Capitol Peak HTD test bed, SHIST, and Alt. SHIST sites would be expanded and additional granite and limestone test beds would be established. However, the present boundaries of PHETS and LB/TS would remain unchanged.

Several types of ground-disturbing activities would take place at all test sites (except LB/TS) that would alter the topography to varying degrees. Development of two-track roads, placement and removal of temporary target structures, installation of test support infrastructure, and cross-country travel by air sampling vehicles would cause ruts and erosion in the vicinity of all the test beds. Cross-country travel could create vehicle tracks in relatively pristine landscape. These tracks could have a long-term effect but, since they would be within the presently defined boundaries of the test areas, would not be considered significant. However, vehicle tracks created by proposed action activities could be significant if they were to destroy, obscure or otherwise impact historical tracks or roads that are associated with the Trinity Site.

Topography near SHIST site (source: Walcoff Environmental, WSMR).

Excavation, construction, static high explosive, rock penetration, and hard target defeat tests would likely result in substantial changes to the topography within all test beds. Construction at the Capitol Peak HTD test bed expansion area (and additional tunnel

targets) and the proposed Mockingbird South test bed would create swaths of ramped sediment in relief above the surrounding hillsides and valley floor; berms and firing pads near tunnel entrances at Mockingbird South would create raised mounds several meters high. Activities associated with warhead recovery would occur at all sites and could require extensive use of earth moving equipment. Explosions from tests would result in craters caused by explosions in the test areas. The size of these craters could vary from several meters to tens of meters, depending on the amount and type of the explosive tested. Some of these topographic changes could be significant, particularly at the Capitol Peak HTD test bed (explosions up to 500-tons equivalency) and the SHIST test beds where large-scale explosive tests have been proposed.

Some changes to topography, particularly at the Capitol Peak HTD and SHIST test beds, could be significant.

Mitigation measures are proposed to minimize the consequences of proposed DTRA activities. Vehicles could be kept mainly to existing roads and off-road travel could be limited, with a few exceptions (e.g., placement of testing infrastructure, plume tracking, and recovery activities). Proposed new roads to provide test bed access could be evaluated and approved by White Sands Environmental Services Division (WS-ES) prior to construction. Following the end of their usefulness as test beds, all sites could be returned to their approximate original contours to the greatest extent feasible. Impact craters and depressions caused by explosions or recovery activities could be filled and returned to approximate original contours. In cases where recovery activities are prolonged due to extensive data collection efforts, craters and depressions could be filled within two years of testing event.

4.1.1.2 Impacts of Alternative Two

The addition of chemical simulants as proposed in alternative two would result in essentially the same impact on topography as the proposed action.

4.1.1.3 Impacts of the No Action Alternative

The no action alternative would allow DTRA activities to continue at approximately the current level of magnitude under existing environmental documentation until their effective expiration. The no action alternative would result in generally less impact to topography in the DTRA test bed areas. Mockingbird South and additional Capitol Peak HTD tunnel targets would not be built. The existing landscape at these two locations would be left essentially unchanged, and earth material would not be generated from excavation activities. SHIST and Alt. SHIST test beds would not be expanded. Under this alternative, additional land area would not be subjected to weapon impacts and

warhead recovery activities that would alter the terrain. The testing of large-scale explosives (up to 500 tons TNT equivalency) at the Capitol Peak HTD test bed would not occur; thus, there would be no expectation for detonation of these weapons to change the local topography. Selection of the no action alternative would result in less overall ground disturbance in the DTRA test bed areas.

4.1.2 Impacts to Aesthetics and Visual Resources

Potential impacts to visual resources would be considered significant if the proposed action, alternative two, or the no action alternative were to substantially degrade the natural or constructed physical features at WSMR that provide the WSMR landscape its character and value as an environmental resource.

4.1.2.1 Impacts of the Proposed Action

Impacts were evaluated with criteria to determine whether they would be significant. One of the most important factors considered in the evaluation of aesthetic and visual resource impact is how visible the changes are from viewpoints both on-installation and off-installation.

The magnitude of impact would be determined by:

- **number of viewers affected**
- **viewer sensitivity to these changes**
- **distance and atmospheric conditions of viewing**
- **compatibility with existing land uses**

Proposed action mission and support activities at various DTRA test beds (except LB/TS) would include explosives testing, and construction. These activities would contribute to the already disturbed appearance of the landscape in established test beds, and result in visual changes to some previously undisturbed areas. Craters from explosive testing would be obvious blemishes on the landscape to observers in the area. Construction activities would create dust visible to drivers on WSMR roads. Berms, tunnels, nonpermanent structures at PHETS, and other infrastructure constructed under the proposed action would also be visible from some local roads.

The greatest visual change would be construction of additional Capitol Peak HTD tunnel targets and Mockingbird South tunnel targets. Construction at Mockingbird South, with

the needed access roads, would occur in an essentially pristine area on WSMR with the exception of one graded road. Expansion of the SHIST test bed would also affect visual aesthetics. At SHIST, on-going rock penetration tests would create more craters and obvious visual ground disturbance noticeable from Range Road 7 (although at considerable distance). A portion of the Capitol Peak HTD test bed is visible from Range Road 7. Alt. SHIST is not readily visible from any area that is commonly or frequently used by WSMR personnel or public visitors.

There would be no significant impact to the aesthetics of test bed areas under the proposed action.

While there would be some additional degradation to the aesthetics of test bed areas under the proposed action, these would not be significant based on historic and on-going use patterns. The number of viewers is primarily limited to the work force supporting activities on northern portion of WSMR. These viewers generally tend to have reduced sensitivities to potential visual impacts and are more accepting to test infrastructure and activities potentially affecting the environment. Furthermore, DTRA facilities and activities are compatible with the existing land use of WSMR.

Mitigation measures are proposed to lessen the visual impact of DTRA activities under the proposed action. Test support vehicles could use existing roads and keep within test bed boundaries. Off-road travel could be limited to placement of testing infrastructure, plume tracking and recovery activities using a single path in and out. Following the end of their usefulness as test beds, these areas could be returned to their approximate original contours to the greatest extent feasible. Impact craters and depressions caused by explosions or recovery activities would normally be filled in and returned to approximate original contours following testing. In cases where recovery activities are prolonged due to extensive data collection efforts, craters and depressions could be filled within two years of testing.

4.1.2.2 Impacts of Alternative Two

The addition of chemical simulants as proposed in alternative two would result in essentially the same impact on aesthetics and visual resources as the proposed action.

4.1.2.3 Impacts of the No Action Alternative

The no action alternative would allow DTRA activities to continue at approximately the current level of magnitude under existing environmental documentation until their effective expiration.

The no action alternative would result in generally less impact to aesthetics and visual resources in the DTRA test bed areas. Mockingbird South and additional Capitol Peak HTD tunnel targets would not be built; views of these landscapes would not be adversely impacted. SHIST and Alt. SHIST test beds would not be expanded, thus preserving the visual appeal of the undisturbed ground. Lower-magnitude explosive tests throughout the DTRA test beds would create fewer and smaller craters and lessen the impact on this resource. Selection of the no action alternative would marginally reduce overall effects to aesthetics and visual resources compared to the proposed action.

4.1.3 Impacts to Climate

Impacts would be considered significant if the proposed action, alternative two, or the no action alternative were to measurably affect the climate on a local or regional scale.

4.1.3.1 Impacts of the Proposed Action

Several collateral effects test materials (sulfur hexafluoride, carbon tetrafluoride, and bromine triflouride) have been identified as greenhouse gases (Appendix F) that contribute to the problem of global warming. However, only very small amounts of these tracer gases are used in biological simulant tests and their use is not restricted. Interferent-type test materials, including burning plastic and tires, would produce relatively small quantities of carbon dioxide, a well-known greenhouse gas, through combustion. Considering the small quantities of greenhouse gases conceivably generated under the proposed action, DTRA activities would not significantly impact the climate on any scale.

Considering the small quantities of greenhouse gases conceivably generated under the proposed action, DTRA activities would not significantly impact the climate on any scale.

4.1.3.2 Impacts of Alternative Two

The impacts of alternative two would essentially be the same as those of the proposed action and would not significantly impact the climate on any scale.

4.1.3.3 Impacts of the No Action Alternative

The no action alternative impacts to climate would be essentially the same as those of the proposed action because the current use of these greenhouse gases would not change.

4.1.4 Impacts to Geology and Soils

This section analyzes the potential impacts of the proposed action, alternative two, and the no action alternative to geology and soils in the vicinity of the DTRA test beds at WSMR. An overview of the geology and soils that could be potentially affected by DTRA activities is found in Section 3.1.4, Affected Environment, Geology and Soils.

Impacts to geology and soils from the proposed action, alternative two, or the no action alternative would be considered significant if they were to:

- **Cause substantial soil erosion or compaction such that biotic communities are seriously threatened**
- **Degrade soil chemical quality such that humans, plants, or animals have the potential to be significantly adversely affected through chemical uptake**
- **Substantially affect the future ability to use geologic resources**
- **Cause damage to unique geologic features**

4.1.4.1 Impacts of the Proposed Action

Using the significance criteria, this section evaluates how proposed action testing and support activities would impact soil and geology.

Impacts to Soil Physical Quality. Proposed action testing and support activities that result in ground disturbance from construction, explosive detonations, excavations, earth-penetrating weapons, demolitions, and ground maneuvers, including vehicular traffic, were analyzed for potential impacts to soil physical quality. Impacts to soil physical quality were assessed for soil compaction and soil erosion (soil loss). Soil types and percent slope, which can greatly enhance soil compaction and soil erosion effects, were assessed at the locations of proposed activities (Section 3.0, Affected Environment).

Existing ground disturbance at PHETS test bed (source: Walcoff Environmental, WSMR).

Explosive detonations, earth-penetrating warheads, and excavations would disturb near-surface and subsurface soil horizons within all DTRA test beds to varying degrees. Other disturbances to near-surface soils would result from increased vehicle traffic that would be used for plume-tracking and sensor placement for collateral effects and other tests;

some of these activities would be in previously undisturbed areas. In addition, on-going construction and upgrade activities at the PHETS Administrative Park would also cause localized soil disturbance. Soil compaction and erosion are discussed individually in the sub-sections that follow.

Soil Compaction. Soil compaction refers to processes that tend to consolidate or decrease the volume of soil. Passage of vehicles disaggregates and/or compacts the soil, crushes herbaceous and woody vegetation, and exposes the soil to the erosive forces of raindrop impact, surface water runoff, and wind (Quist, *et al*., 2003), and increases slope runoff. Compacted or rutted soil inhibits vegetative growth and experiences more frost heave than uncompacted or unrutted soil (Gatto, 2001). Generally, the degree of soil compaction is proportional to the level of traffic or surface pressure. Compaction may only be slight if a vehicle passes straight across an area only one time; however, repeated passes in the same area may cause long-term damage.

Cryptobiotic soils are distributed throughout WSMR and are vulnerable to destruction from vehicular traffic because such traffic causes soil compaction. Cryptobiotic soils are formed by living soil crusts dominated by cyanobacteria, but also include soil lichens, mosses, green algae, microfungi, and bacteria. Vehicle tracks in continuous strips are especially damaging, creating areas that are highly vulnerable to wind and water erosion. Rainfall carries away loose material, often creating channels along these tracks, especially when they occur on slopes.

Soil compaction is an adverse impact expected to occur as a result of ground disturbance caused by various activities required under the proposed action. Expanding current test beds would cause the greatest increase in ground disturbance, including soil compaction and resulting erosion. Under the proposed action, the boundaries of SHIST, Alt. SHIST, and the Capitol Peak HTD test bed would be extended into adjacent bedrock, resulting in soil compaction and erosion (primarily from the anticipated access roads into the new areas). Construction of the proposed Mockingbird South test site and the use of heavy equipment would also potentially result in localized soil compaction and erosion.

Expanding current test beds would cause the greatest increase in ground disturbance, including soil compaction and erosion.

While the proposed expansion of the HTD test bed at Capitol Peak, SHIST, and Alt. SHIST; and establishment of new test beds would account for the majority of ground disturbance, other activities are proposed that would also cause ground disturbance and

increase soil compaction at these sites. Other associated testing activities that would result in an increase in soil compaction include:

- Increased number of vehicles and personnel associated with testing activities
- Constructing access roads to new test bed extension areas
- Leveling and maintaining test beds
- Demolishing obsolete target structures
- Excavating inert warheads

It is expected that the proposed action would result in long-term, adverse impacts to the physical quality of the soils within the test beds and access routes due to increased soil movement and compaction.

Soil Erosion. Soil erosion refers to the group of processes (via water, ice, or wind) whereby soil is loosened or dissolved and moved to another location. Soil erosion is directly related to the biological productivity of a site, and testing activities directly and indirectly affect erosion rates. Many of the soils at WSMR are naturally prone to wind erosion, as a consequence of their weak structure, which is related to low levels of organic material and high levels of sodium (Dregne, 1985). The well-developed dune complexes in both the Tularosa and Jornada del Muerto basins are evidence of such soil movement by wind processes.

Damage to the fragile vegetative cover related to testing activity at WSMR (and to a smaller extent, on DTRA test beds) exposes these generally sandy soils, increasing the damage caused by wind erosion. Soil loss from wind erosion, and resultant dust, is a major problem in areas where stabilizing shrubs and grasses are disturbed, such as in test beds and impact areas. Stabilizing exposed soil may take years; thus, maintenance of adequate vegetative cover for soil protection is important.

Wind erosion of soil at all DTRA test sites is a constant hazard wherever ground-disturbing activities occur. Soils have the potential for disturbance by a variety of testing-related activities, including: construction, excavation, explosives detonation, projectile recovery, and construction of new roads and improvements to existing roads. Construction of additional Capitol Peak and Mockingbird South tunnel targets for HTD testing would displace soil on hillsides and bury existing natural soils with spoil. Test-related explosions at all test beds would disturb soils near impact sites.

Water erosion hazard is generally slight to moderate, except on steep slopes because most of the soils at WSMR are well drained and permeable. Evidence of significant headward and gully erosion has not been noted in the drainages at any DTRA test bed. Soils located on steep slopes are most prone to water erosion, mainly through sheet-wash. At Alt. SHIST and the Capitol Peak HTD test bed (including the expansion areas), Rockland Warm and Rockland Cool Soils are located on steep slopes along the mountain fronts and thus have a severe water erosion hazard. Ground disturbing activities (such as excavation, site preparation, and projectile recovery) at these sites could accelerate water erosion on these thin rocky soils.

Soil erosion at DTRA test beds is a long-term adverse impact that is expected to occur as a result of ground disturbance caused by proposed action activities.

Proposed action activities are expected to increase soil compaction and erosion potential as described above. Because compacted soil inhibits vegetative growth and recovery, it is anticipated that this would directly cause an increase in bare ground, leading to an increase in soil erosion. Additionally, the expansion of test beds and consequent increase in magnitude and frequency of explosive detonations would increase soil disintegration and erosion. Wildfires caused by testing activities would increase bare ground and soil erosion potential as well.

Impacts to Soil Chemical Quality. This section briefly discusses potential impacts to soil chemical quality from collateral effects test materials that would be released under the proposed action. Test materials (and their characteristics and hazards) used and proposed for use at DTRA test beds are presented in Appendices E, F, G, and H. Potential soil contamination as a cumulative effect is discussed in Section 5.2.2.

No significant impacts to soil chemical quality are expected from release of any of the collateral effects test materials.

Collateral Effects Test Materials. Release of CBR simulants and other test materials would be expected to increase due to greater frequency of collateral effects testing. Test materials would settle upon the soil following collateral effects tests, with the highest concentrations occurring nearest the test structures. The mobility and residence time of these substances in the soil system is governed by their physical characteristics such as volatility, degradation rate, and adsorption to soil particles.

No significant impacts to soil are expected from the biological simulants. *Bacillus subtilus* var. *niger*, *Bacillus thuringiensis*, *Clostridium sporogenes, and Erwinia herbicola* are bacterial populations that widely occur naturally, either in soil or on plant surfaces. Introduced foreign bacteria would not compete with indigenous soil microbial populations (Dr. William Lindemann, soil microbiologist, New Mexico State University, pers. comm., 2001); thus, these introduced populations would be self-regulating. Soil microbes would rapidly break down the biological simulants ovalbumin and lactic dehydrogenase. Bacteriophage MS2 is a virus that only infects bacteria and has no effect on higher organisms. The Influenza A virus used would be killed and, therefore, have no infectious potential.

Prior to each test, WSMR ES should be provided a list of individual strains and/or sources of all biological simulants for review to limit potential impacts.

Other test materials that are volatile organic compounds (VOCs) should not adsorb to WSMR soil. Chemical adsorption depends on soil organic content and salinity. The highly saline and low organic soils at WSMR discourage soil adsorption of VOCs (which tend to vaporize at room temperature and would rapidly dissipate into the atmosphere).

An overall increase in the release of tracers and taggants would occur during collateral effects testing. Volatile tracer gases should not adsorb to soil because adsorption depends on salinity and organic content. The highly saline and low organic soils at WSMR discourage soil adsorption of tracer gases. Most plume taggants are exotic materials meant for one-time use only. They are released along with simulants and are used to visually track the plume. Some taggants, such as the rare earth oxides, are generally non-toxic; these include alumina, dysprosium oxide, and indium oxide. Kaolin, a type of clay used in ceramics, is also used as a plume taggant and is non-toxic. Other proposed taggants, including inorganic and organic compounds have varying toxicities, depending on exposure amount (Appendix G). Tracers and taggants used under the proposed action are not expected to have a significant effect on soil chemical quality.

Many of the non-VOC test materials would be adsorbed by the soil. Environmental impact regarding these adsorbed chemicals would be expected when the rate of deposition exceeded the breakdown rates (assuming no other losses, which almost certainly would occur). Biological half-lives of these test materials range from minutes to years (Appendix H); however, it is likely that materials would only potentially accumulate in the soil very near test bed release points. Post-test analyses by DTRA and

contractors of areas near test material release points have not found evidence for accumulation.

A test series was conducted at the Hazardous Spill Center at Nevada Test Site, Nevada, in which crop duster airplanes released the simulant dimethyl methylphosphonate (DMMP). In conjunction with this field test, the DTRA Hazard Prediction and Assessment Capability (HPAC) computer model was used to predict the results of this test series. It was found that the HPAC model results were comparable with the actual experimental results. The analytical results of the HPAC model showed a peak surface deposition of 100 milligrams per square meter for a 454 kilograms release (Espander, 2005 [Appendix I]). The amount of DMMP deposited on the surface was very small, and soil half-life for this compound ranges from 0.2-60 days, depending on concentration and temperature (USNLM, 2003). The small amount of DMMP that would be deposited on the soil surface would not significantly affect soil chemistry, nor would it be expected to persist in the soil for any extended length of time. This and other simulants applied in similar aerial applications and quantities at DTRA test beds at WSMR would be expected to have a comparable fate. Thus, aerial applications of simulants are not expected to have a significant effect on soil chemical quality.

To evaluate impacts to soil chemical quality from past simulant testing, soil grab samples were collected in October 2003 from the two most recently used test beds at PHETS. Sampling locations were chosen downwind from the release points based on weather data on test days. These samples were analyzed for DMMP, TEP, and DPGME. The simulants were not detected in any of the soil samples, indicating that past collateral effects testing had not resulted in residual soil contamination. Impacts of the proposed action to soil chemical quality can be assumed to be similar and also not significant.

No significant impacts to the soil are expected from the use of the proposed radiological simulants: cesium dioxide, manganese dioxide, cesium chloride, and strontium titanate (Appendices E and F). These non-radioactive materials could accumulate near their release point, but would not have a significant impact on soil chemical quality.

Heavy metals have the potential to accumulate in the soil from explosive testing activities, especially from munition residues and exhaust from vehicular traffic. Munition residues would result from weapons (live and inert) used in testing activities. Frequency of these activities is projected to increase under the proposed action. However, there would not be any appreciable accumulation of explosive residues as test beds are checked and cleared by Explosive Ordnance Disposal after every test. Thus, any heavy metal contamination of soil would be limited to very small areas, and relatively

similar to/the same as what currently occurs. Any clean up of sites would be evaluated on an as-needed basis once testing was completed or when the site was no longer going to be used.

Proposed Soil Mitigations. Soil erosion and compaction mitigation measures are proposed to address repairing damage to areas used by DTRA and improving site conditions for testing activities.

Any proposed mitigation measures for addressing soil compaction and erosion should focus on maintaining or restoring vegetative cover. Adequate vegetative cover for soil protection is critical at WSMR, where soils are naturally prone to wind erosion as a consequence of weak soil structure related to low levels of organic matter or high levels of sodium. Impacts of the proposed action could potentially disturb surface soils and reduce soil productivity. If vegetative loss were excessive, serious soil erosion could result.

Additional proposed mitigations for reducing degradation of the physical quality of the soil caused by ground disturbance includes the following measures:

- When possible, use only existing roads, or if new roads need to be created, place these in areas that could minimize impacts to vegetation. An appropriate level of NEPA review could be conducted for all proposed new roads. Upon test bed closure, road areas would be remediated with the test beds.

- Manage all fires in accordance with the WSMR Fire Management Plan

- The relatively steep slopes along the mountain front at Capitol Peak HTD and SHIST test beds (including expansion areas) have potential for accelerated erosion of alluvial soils. Appropriate erosion control measures could be implemented at the discretion of the White Sands Environment and Safety Directorate (WS-ES) land manager, to include alternating, angled water bars, terracing, or other erosion control structures.

- Dust abatement measures could include the use of water spray trucks and application of soil stabilizers. The WS-ES land manager could also direct additional measures for soil erosion control.

- To address degradation of soil chemical quality, proposed mitigation should include an appropriate soil monitoring program. Soil monitoring for

simulant fallout should be conducted annually after collateral test events. Soil grab samples should be taken down wind and in close proximity to respective test beds. Soil samples should be analyzed for presence and concentration of particular simulants used in a given test year. Soils found to have high simulant concentration levels may need to be removed if required to protect human health and the environment.

Impacts to Geology. Impacts to geologic features and resources were analyzed by comparing the locations of such features and resources to the locations of activities under the proposed action. HE tests at PHETS would not significantly affect bedrock formations, which are deeply buried by alluvium. At SHIST and Alt. SHIST, projectile impacts into bedrock would affect only very small areas within the individual test beds; these impacts would not affect bedrock resources significantly on any larger scale.

Weapons testing against tunnel targets at the Capitol Peak HTD area would locally disturb rocks at the site, which consists predominantly of Precambrian granite. Test-related explosions are anticipated on or near the tunnel entrances (portals). Additional tunnel targets would be constructed by blasting and/or mechanized earth-moving in the expansion areas adjacent to the present HTD test bed, and in granite terrain at Mockingbird South. Access roads in previously undisturbed Quaternary alluvium would potentially affect this resource. Precambrian granite and Quaternary alluvium, however, are well represented throughout much of the San Andres Mountains and vicinity. Disturbances anticipated by project activities would affect relatively small, localized areas of bedrock.

View of the San Andres Mountains from PHETS (source: Walcoff Environmental, WSMR).

No geologic resources would be significantly affected by proposed action activities.

There are no commercially valuable metallic or nonmetallic mineral resources, or unique geologic features at any DTRA test bed that would be affected by testing activities. Concrete, sand, and gravel used for construction activities would have a minor affect on raw geologic materials, such as deposits of limestone and sand.

4.1.4.2 Impacts of Alternative Two

The addition of chemical simulants as proposed in alternative two would result in essentially the same impact on geology and soils as the proposed action. These simulants

would be released into the air during collateral effects testing and would settle upon the soil. The highest concentrations of these simulants would occur nearest the structures were collateral tests would take place. The mobility and residence time of these substances in the soil system is governed by their physical characteristics such as volatility, degradation rate, and adsorption to soil particles. Chemicals added to the second alternative include diisopropyl fluorophosphate (DFP), 2-chloroethyl ethyl sulfide (CEES), diethyl methyl phosphonate (DEMP), diisopropyl methyl phosphonate (DIMP), and bis (2-ethylhexyl) phosphate (DEPHA). Details about alternative two simulants can be found in Appendices E, F, G, and H.

Diisopropyl fluorophosphate (DFP) is expected to have very high mobility and volatization from moist soil surfaces and is likely to leach. It is unlikely to adsorb to soil particles in the environment and concentrate in organisms.

In the soil, 2-chloroethyl ethyl sulfide (CEES) is expected to have high mobility. Volatilization from moist soil surfaces would not be an important fate process due to its hydrolysis rate; the extrapolated hydrolysis half-life of 2-chloroethyl ethyl sulfide in pure water at 25 C^{o} is about 44 seconds. Due to rapid hydrolysis, leaching in soil will not be important. 2-chloroethyl ethyl sulfide may volatilize from dry soil surfaces based upon its vapor pressure. The extrapolated hydrolysis half-life of 2-chloroethyl ethyl sulfide in pure water from studies in ethanol-water and acetone water at 25°C is about 44 seconds (USNLM, 2002).

Diisopropyl methyl phosphonate (DIMP) is expected to have high mobility if released in soils and volatilization in dry soil surfaces is expected to be slow. DIMP volatilized in 10 days when applied to dry and moist soil. Biodegradation in acclimated and unacclimated soil takes about 1 and 3 years.

Bis (2-ethylhexyl) phosphate (DEPHA) adsorption to soil should be moderately strong and is likely to persist in the soil. However, the adsorption should become weaker as the pH of the media increases. DEPHA will most likely adsorb to soil, but it is unlikely to leach into the groundwater because of its low solubility. It will possibly bioaccumulate in organisms and persist in soil.

Due to the small amounts of chemical simulants expected to be deposited on the soil surfaces, soil chemistry would not be significantly affected. However, many of these simulants could persist in the soil for some time. If alternative two is chosen an appropriate annual soil-monitoring program should be initiated as described in Section 4.1.4.1.

4.1.4.3 Impacts of the No Action Alternative

The no action alternative would allow DTRA activities to continue at approximately the current level of magnitude under existing environmental documentation until their effective expiration.

The no action alternative would result in generally less impact to geology and soils in the DTRA test bed areas. Mockingbird South and additional Capitol Peak HTD tunnel targets would not be built. This would prevent potential soil compaction and erosion in these areas. SHIST and Alt. SHIST test beds would not be expanded, and weapon impacts would not disturb the rock and soil in these areas. DTRA would continue to conduct the lower-magnitude explosive tests currently performed, which would be a marginal reduction in damage to rock and soil than in the proposed action alternative. Selection of this alternative would reduce overall effects to geology and soil resources compared to the proposed action.

4.1.5 Impacts to Seismicity

Impacts would be considered significant if the proposed action, alternative two, or the no action alternative were to cause movement along faults in the underlying bedrock and generate earthquakes.

4.1.5.1 Impacts of the Proposed Action

A major fault zone is located near the western boundary of the Tularosa basin, which is formed by the eastern margin of the San Andres and Oscura mountains (Machette et al., 2000). HTD test bed, SHIST, and Alt. SHIST are located in the San Andres and Oscura mountains in this region. Faults in this zone have moved during the late Pleistocene epoch (2 million to 8,000 years ago) and/or early Holocene epoch (within the last 8,000 years) (Machette, 1987). High explosives tests (or other DTRA activities) would not generate the extreme magnitude forces required to cause movement along this fault system or increase the probability of an earthquake occurring in the WSMR area. Furthermore, the western Tularosa basin faults near the DTRA test beds are confined to WSMR and unrelated to any earthquake activity that has occurred in the Socorro, New Mexico area (Machette et al., 2000).

Proposed DTRA activities would not cause movement along any fault system or increase the probability of an earthquake.

No major fault zones have been identified within WSMR boundaries west of the San Andres Mountains and in the Jornada del Muerto Basin (Machette et al., 2000) where

PHETS and LB/TS are located. Thus, the proposed action would have no effect on seismicity.

4.1.5.2 Impacts of Alternative Two

The addition of chemical simulants as proposed in alternative two would result in no effect on seismicity which is essentially the same as the proposed action.

4.1.5.3 Impacts of the No Action Alternative

The no action alternative impact is essentially the same as that of the proposed action with regard to seismicity.

4.1.6 Impacts to Water Resources

This section analyzes the potential impacts of the proposed action, alternative two, and the no action alternative to surface water and ground water in the northern part of WSMR. The criteria used to evaluate whether these potential impacts are considered significant, and the mitigation measures that could be implemented to reduce any adverse impacts are presented. The existing surface water and ground water environments are described in Section 3.1.6.

Impacts resulting from the proposed action would be considered significant if they were to:

- Substantially alter surface flow conditions, patterns, or rates
- Cause substantial flooding or siltation
- Substantially degrade surface water quality with regard to biota either directly or indirectly as a result of bioconcentration or bioaccumulation
- Substantially decrease availability of surface water to wildlife
- Substantially increase the potential to adversely affect ground water quality
- Cause noncompliance to applicable water quality standards
- Substantially lower an aquifer water table or potentiometric surface such that aquifer depletion would be a concern
- Substantially alter ground water recharge to an aquifer

4.1.6.1 Impacts of the Proposed Acton

This section evaluates surface water and ground water impacts with these significance criteria in detail for the proposed action. The following subsections describe the impacts of the proposed action to surface water quantity, surface water quality, ground water quantity, and ground water quality.

Impacts to Surface Water Quantity. As described in Section 3.1.6, Water Resources, the only natural perennial surface water features that occur in the area are mountain springs. Since ground water would not be withdrawn near the DTRA test beds, the quantity of water flowing to area springs, seeps, and wells would not be affected. All other surface water features in the area are ephemeral. These depend entirely upon precipitation and would not be affected by the proposed action.

Proposed action mission and support activities would have no effect on the quantity of surface water in the region.

Apart from springs that are fed by ground water discharge and Salt Creek, natural surface water flow is ephemeral in surface water drainages at WSMR. Small playa lakes or intermittent streams may form after sufficient rainfall events, but these evaporate or infiltrate rapidly and are short-lived. Under the proposed action, regional or large-scale changes to natural surface water flows would not occur. However, a number of activities associated with testing and support activities (e.g., warhead impacts and related recovery efforts) would cause ground disturbances resulting in an increased potential for soil erosion and compaction as described in Section 4.1.4, Impacts to Geology and Soils. Increased soil erosion and compaction could cause increased surface water runoff and accelerated soil erosion in local areas.

Increased surface water runoff due to soil erosion and compaction would be localized and specific to the activity and topography in which the activity occurs. These impacts would not be significant in the low-lying basin areas due to the high evaporation and infiltration rates. Areas that have high topographic relief may have increased surface water runoff due to erosion and compaction. Increased surface water runoff could be detrimental to vegetation in these areas. This is a long-term, adverse, indirect impact to vegetation in areas of high topographic relief used for testing.

Increased surface water runoff is expected from construction projects identified in the proposed action. Impacts from this runoff would most likely not be significant because they would be localized and short-term during the construction activity.

The proposed action would not cause flooding. Given the high infiltration and evaporation rates in the region, flooding is controlled by the amount of precipitation rather than increased surface water runoff from disturbed areas.

Impacts to Surface Water Quality. Proposed action mission and support activities were analyzed for potential impacts to the quality of northern WSMR surface water. Locations of natural surface water features were analyzed with respect to the proposed action discussed in Section 2.0. As discussed in Section 3.1.6, Water Resources, the only perennial surface water bodies on WSMR are mountain seeps and springs; Salt Creek; ponds and a wetland associated with Mound Springs and Malpais Spring; and Lake Lucero. The proposed action was analyzed for potential to degrade the quality of surface water by introduction of test materials and sediment.

Mound Springs in the Tularosa Basin (source: Walcoff Environmental, WSMR).

A portion of the test materials released into the air at PHETS and other DTRA test beds during collateral effects tests would eventually settle out on the land surface. Most of the material would evaporate, react, or rapidly degrade in the sunlight (photodegrade). Under rare conditions, such as a heavy rainfall event immediately after dispersion of the test material, it is conceivable that part of the remainder may be entrained or dissolved in surface water runoff. However, with the exception of the immediate areas around the test material release points, it is expected that only very low concentrations would be deposited over downwind areas. Furthermore, losses from evaporation, reactions, and photodegradation; and the infrequency of heavy rains would prevent the concentration of substantial amounts of test materials in surface water runoff.

Perennial surface water bodies in the Tularosa Basin are located several kilometers from DTRA test sites and would not be significantly affected by collateral effects tests because of the distances involved. Salt Creek is located in the Tularosa Valley watershed southeast and down gradient from the Capitol Peak HTD test bed. It is an important surface water feature because it contains essential habitat for the White Sands pupfish (*Cyprinodon tularosa*). However, Salt Creek is separated from this test bed by more than 10 km (6 mi) of dry sediments in an ephemeral drainage. Due to distance, water in Salt Creek would not be chemically degraded by either silt or test materials entrained in surface water runoff from the test bed. Surface water runoff from the HTD test bed would infiltrate into the ephemeral drainage long before reaching Salt Creek.

Significant atmospheric deposition of simulants and other test materials into Tularosa Basin surface water bodies would not occur due to the distance from the release sites. The HPAC model was used to predict the potential for simulant plumes released during collateral effects tests at Capitol Peak HTD test bed to reach Tularosa Basin surface waters (Espander, 2004 [Appendix J]). Using parameters for actual weather data for the region and two different representative simulants, Bg and dimethyl methylphosphonate (DMMP), it was found that any surface deposition to Mound Springs, Malpais Spring, and Salt Creek would be extremely small. At all three sites, maximum surface deposition of Bg and DMMP would be 1.0 x 10^{-11} kg/m^2 and 1.0 x 10^{-7} kg/m^2, respectively. Furthermore, these concentrations were shown to decrease exponentially within short distances of maximum surface deposition.

The following examples are provided to put in perspective the significance of the surface deposition of Bg and DMMP predicted by the HPAC model. The model predicted that the maximum amount of Bg that would be deposited on the surface of Mound Springs, Malpais Spring, and Salt Creek would be 1.0 x 10^{-11} kg/m^2, and the maximum amount of DMMP would be 1.0 x 10^{-7} kg/m^2. If it is assumed that 1.0 x 10^{-11} kg/m^2 of Bg is deposited to a shallow body of water 1.0 m deep, and complete mixing occurs, the resulting concentration would be 1.0 x 10^{-8} mg/L. The reported LC_{50} value (the dose at which half of the fish died in a controlled experiment) for a 96-hour exposure of Bg was greater than 400 mg/L (Appendix G). The predicted maximum concentration of Bg deposited to a body of water 1 m deep would result in a concentration 40 billion times less than the LC_{50} value for fish. Likewise, if it is assumed that 1.0 x 10^{-7} kg/m^2 of DMMP is deposited to a shallow body of water 1.0 m deep, and complete mixing occurs, the resulting concentration would be 0.1 µg/L. The Lifetime Health Advisory Level (HAL) for DMMP established by the U.S. Environmental Protection Agency, which is the estimate of the concentration of a chemical in drinking water that is not expected to cause any adverse non-cancer effects for a lifetime of exposure, is 100 µg/L (U.S. EPA, 2000). The model predicted maximum amount of DMMP deposited to a body of water 1 m deep would result in a concentration one thousand times less than the Lifetime HAL value. The previous were worst-case scenarios based on predictions of the HPAC model and were presented for illustrative purposes only; theoretical water concentrations of Bg and DMMP would vary depending on water depth and flow rate.

The proposed action would not affect the chemical quality of water in springs located in the San Andres and Oscura mountains. The spring nearest to the Capitol Peak HTD test bed and Alt. SHIST is located approximately 6 km (3.7 mi) away in a different local watershed; and the spring nearest to SHIST is located approximately 5 km (3 mi) away.

The surface water drainage system in the Capitol Peak, Alt. SHIST, and SHIST areas may be affected through construction of new test beds and access roads. Chemical degradation of surface water quality due to siltation or deposition of soil containing test materials is not expected because all springs are located well outside the test bed areas and would not be affected by surface water runoff. Atmospheric deposition of test materials would also not likely affect the chemical quality of springs because none are located near the project areas.

Surface water quality would not be degraded by proposed action activities.

Certain erosion control measures could be used to mitigate effects from test bed expansion and construction at all DTRA test beds. Retention ponds, stabilization measures for disturbed areas, and sediment traps would be used as applicable. Construction activities would be planned to minimize changes to existing drainage patterns. The use of culverts for road-crossings through arroyos, recontouring, and other best management practices would be implemented.

Impacts to Ground Water. The proposed action was analyzed for potential impacts to regional ground water quantity and quality including: impacts due to water usage demands on an aquifer (which could lead to aquifer depletion or impact aquifer recharge); and contamination of aquifer recharge areas by project-related materials and wastes (which could degrade the chemical quality of ground water through leaching into the subsurface). The existing ground water in the northern portion of WSMR is mostly poor-quality (brackish) and non-potable (Section 3.1.6, Water Resources).

Proposed DTRA activities would have little affect on ground water quantity in the region.

DTRA activities are not water-intensive and would have little affect on the quantity of ground water in the region. Potable and non-potable water would be transported to DTRA test beds by water trucks from existing sources within WSMR, mainly production wells near Stallion Range Center. (The PHETS Administrative Park has scheduled [weekly] deliveries). Water is used for making concrete occasionally at the batch plant on Range Road 7. Regional or local ground water tables would not be lowered due to ground water withdrawal in support of DTRA activities. In addition, the proposed action would not cause any major changes to surface water flow patterns, and indirectly affect aquifer recharge.

Under the proposed action, static explosive and air-delivered warhead tests would not affect ground water resources at DTRA test beds. Most of the explosives and warheads tested at PHETS are not large enough to conceivably impact ground water. Large ammonium nitrate-fuel oil (ANFO) tests of the type conducted in the 1970s and 1980s at PHETS could have left behind leachable materials, including nitrate and nitrite. These materials could have then migrated into ground water under the test site. However, this was not likely to happen because in areas where the large static detonations were conducted, depth to ground water was over 60 m (200 ft). Due to low precipitation levels, high evaporation rates, and impermeable subsurface layers under the test sites, it would be unlikely that surface water, and thus dissolved contaminants, could infiltrate to this depth. Ground water chemistry data was collected to determine if surface materials had leached into ground water under the test site area. Ground water samples were analyzed for nitrogen to determine if ANFO had been transmitted into the water. A water sample from the DC-1 well, taken in 1983, had a reported dissolved nitrogen concentration (as nitrate and nitrite) of 11 mg/L (USGS, 1985). This sampling pre-dates most of the large ANFO tests done in the area (e.g., DIRECT COURSE, MINOR SCALE, MISTY PICTURE). A sample from a new monitoring well (MW01-3), located very close to the DC-1 well (Figure 3-6), was sampled for dissolved nitrogen (as nitrate and nitrite) in 2001 and was found to have a concentration of 10.7 mg/L (Table 3-3). Thus, the almost identical concentrations of nitrogen in the older well, versus the new monitoring well, indicated that ANFO had not affected the ground water at PHETS. Ground water quality at PHETS (Figure 3-6) should be monitored over time through annual sampling of three new monitoring wells. Thus, based on past results, it is likely that proposed action static explosive and warhead testing would not significantly affect ground water chemical quality.

Proposed action activities are not likely to affect ground water chemical quality in any of the test bed areas.

Under the proposed action, collateral effects tests would be conducted at PHETS and other DTRA test beds, where test materials could potentially leach into the ground water. These test materials could include non-VOC compounds that could potentially accumulate in the soil near the test bed release points. However, an extensive gypsic soil horizon has formed throughout much of the PHETS area, which tends to impede surface water movement toward the relatively deep water table. At the other DTRA test beds in more mountainous settings, the shallow soil cover over impermeable bedrock makes it unlikely that ground water exists in substantial quantities or that it would be significantly affected. The scenario of a large TEP release was analyzed and found to have no

significant effects upon local ground water (FCDSWA, 1998). A proposed annual ground water monitoring program at PHETS should include sampling for simulants used in previous tests such as TEP, DMMP, and DPGME. Past ground water sampling events have not detected these simulants. Future ground water sampling events could include additional simulants, if currently used simulants are detected.

At PHETS, highly water-soluble compounds could potentially migrate to the effective depth of wetting (approximately three to five meters as evidenced by an extensive gypsic horizon) but would not reach the saturated zone. Characteristics of various test materials in surface and ground water environments and their expected fates are presented in Appendix H.

There are no monitoring wells near the Capitol Peak HTD test bed and it is unknown if there is substantial ground water below this site; however, it is unlikely that large quantities exist due to the shallow bedrock in this area. Under the proposed action, storm water sampling devices would be installed in selected areas down gradient from the Capitol Peak HTD test bed. Storm water samples would be taken annually after a rainfall event and analyzed for the presence of recently-tested simulants used at the Capitol Peak HTD test bed. Analytical results would be noted in the monitoring record. If results are positive, WS-ES would be notified to determine appropriate actions.

Inert, non-explosive projectiles are capable of penetrating the thin alluvial cover to reach bedrock at SHIST, Alt. SHIST, and Capitol Peak HTD test bed. Minor amounts of water are surmised to temporarily accumulate in sediments atop bedrock surfaces, especially during the summer rainy season. Impact and projectile recovery disturbances to this highly localized, transitory ground water would be insignificant.

Burris Well, approximately 1.6 km from Alt. SHIST and 2 km from HTD test bed, would not be affected by static explosive, inert warhead, and collateral effects tests. Furthermore, drainage patterns for Alt. SHIST and HTD test bed flow away from Burris Well towards the Tularosa Basin.

Ground water contamination from perchlorate, which is used as an explosive additive, could potentially contaminate ground water around test beds. Most perchlorate would be consumed during explosive testing and very little or no residue would remain. Thus it is unlikely that ground water could be impacted by perchlorate as a result of any proposed action activities. However, as a proposed mitigation, ground water should be monitored at test sites frequently utilizing large quantities of perchlorate based explosives.

4.1.6.2 Impacts of Alternative Two

The second alternative would allow DTRA activities to carry out all of the actions described in alternative one plus the addition of several chemical simulants that are considered to have higher toxicity levels than those considered under the alternative one. Many of these test materials could pose a higher risk to human health and the surrounding environment than those under alternative one. Chemicals added to the second alternative include diisopropyl fluorophosphate (DFP), 2-chloroethyl ethyl sulfide (CEES), diethyl methyl phosphonate (DEMP), diisopropyl methyl phosphonate (DIMP), and bis (2-ethylhexyl) phosphate (DEPHA). Details about alternative two simulants can be found in Appendices E, F, G, and H.

The addition of chemical simulants as proposed in alternative two would result in essentially the same impact on surface water resources as those simulants in the proposed action. There are no perennial streams or surface water bodies located near the DTRA test beds. The closest perennial surface water bodies are located in the Tularosa Basin several kilometers from DTRA test beds. Occasionally small playa lakes or intermittent streams form after sufficient rainfall events, but these evaporate or infiltrate rapidly and are short lived and would not be affected.

The Hazard Prediction and Assessment Capability (HPAC) model was used to predict the potential for simulant plumes released during collateral effects tests at Capitol Peak HTD test bed to reach Tularosa Basin surface waters (Espander, 2004 [Appendix J]). Using parameters for actual weather data for the region and two different representative simulants, Bg and dimethyl methylphosphonate (DMMP), it was found that any surface deposition to Mound Springs, Malpais Spring, and Salt Creek would be extremely small. At all three sites, maximum surface deposition of Bg and DMMP would be 1.0×10^{-11} kg/m^2 and 1.0×10^{-7} kg/m^2, respectively. Furthermore, these concentrations were shown to decrease exponentially within short distances of maximum surface deposition. It is expected that the chemical simulants of alternative two would have similar dispersion characteristics as DMMP and that very low concentrations would be deposited over downwind areas. The remaining material would evaporate, react, or rapidly degrade in the sunlight (photodegrade). Therefore, the additional simulants of alternative two are not expected to have a significant impact on surface water resources.

The proposed chemical simulants of alternative two would have essentially the same impact on ground water resources as the proposed action. These simulants would be released into the air during collateral effects testing and would settle upon the soil. The highest concentrations of these simulants would occur nearest the structures were collateral tests would take place. The mobility and residence time of these substances in

the soil system is governed by their physical characteristics such as solubility, volatility, degradation rate, and adsorption to soil particles.

Bis (2-ethylhexyl) phosphate (DEPHA) is not expected to evaporate considerably from the soil or water. DEPHA will most likely adsorb to soil, but it is unlikely to leach into the groundwater because of its low solubility. Diisopropyl fluorophosphate (DFP) is expected to have very high mobility and volatilization from moist soil surfaces and is likely to leach. 2-chloroethyl ethyl sulfide (CEES) may leach into the ground water due to moderate water solubility. Diisopropyl methyl phosphonate (DIMP) is expected to have high mobility in soil and volatilization from dry soil surfaces is expected to be slow. In water, it is not expected to adsorb to suspended solids and sediment. DIMP has a high solubility and could leach into the groundwater. These chemicals could potentially leach into the groundwater. However, much of the PHETS area is underlined with an extensive gypsic soil horizon. This horizon tends to impede surface water movement toward the relatively deep water table. Other DTRA test beds located in more mountainous settings generally have shallow soil cover over impermeable bedrock making it unlikely that ground water exists in substantial quantities. If alternative two is chosen, an annual ground water monitoring program should take place at DTRA test beds and include sampling for the additional simulants.

4.1.6.3 Impacts of the No Action Alternatives

The no action alternative would allow DTRA activities to continue at approximately the current level of magnitude under existing environmental documentation until their effective expiration.

The no action alternative would result in generally less impact to water resources in the DTRA test bed areas. The expansion in scope of collateral effects tests to include all DTRA tests beds would not take place and the potential for contamination from CBR simulants would be smaller than under the proposed action. Additional tunnel targets at Capitol Peak and Mockingbird South would not be built; which would result in less water usage for these sites, due to no construction, than in the proposed action. Also, maintaining the current testing schedule would require less water for test personnel than in the proposed action. Selection of this alternative would marginally reduce overall effects to water resources compared to the proposed action.

4.1.7 Summary of Proposed Mitigations for Physical Resources

- To minimize impacts to topography, geology, soils and visual resources tests should limit support vehicles to existing roads and test bed boundaries. Off-

road travel should be limited to placement of testing infrastructure, plume tracking and recovery activities using a single path in and out.

- Following the end of their usefulness as test beds, all sites should be returned to their approximate original contours and craters and depressions could be filled within two years of testing completion.

- Appropriate erosion control measures should be implemented on relatively steep slopes having potential for accelerated erosion at the discretion of the White Sands Environment and Safety Directorate (WS-ES)

- Dust abatement measures could include the use of water spray trucks and application of soil stabilizers. The WS-ES land manager may also direct additional measures for soil erosion control.

- To address degradation of soil chemical quality an appropriate soil monitoring program should be implemented.

- Groundwater should be analyzed annually for particular simulants tested at PHETS.

- Storm water samples should be taken annually and analyzed for the presence of recently-tested simulants used at the Capitol Peak HTD test bed.

- Ground water should be monitored at test sites frequently utilizing large quantities of perchlorate based explosives.

- To minimize surface water impacts from proposed test bed expansion and construction activities, appropriate erosion control measures should be implemented.

4.2 Biological Resources

Impacts resulting from the proposed action, alternative two, or no action alternative would be considered significant if they were to:

- degrade critical habitat (e.g., nesting areas, watering areas, etc.) for wildlife

- degrade the ecosystem to the extent that biodiversity is impaired

- adversely impact threatened, endangered, or sensitive (TES) species
- cause substantial mortality or displacement of species
- promote the spread of invasive, non-native species
- cause substantial damage to vegetation communities

4.2.1 Impacts of the Proposed Action

4.2.1.1 Flora

Collateral Effects Testing Using CBR Simulants. An extensive list of simulants, taggants, and other test materials proposed for use are detailed in Appendices E, F, G, and H. With increasing distance from the point of initial release, plume concentrations of various test materials would decrease rapidly (Appendices F, I, and J). If in high enough quantities, test materials released into the air during collateral effects tests could potentially cause plant mortality, impair plant growth, or reduce reproductive success. These effects to plant species would most likely occur nearest the test sites where test materials will be released and plume concentrations will be the highest. Effects to plant life are contingent upon variables including, but are not limited to, chemical type, plant species, temperature, relative humidity, and wind speed. Plant species with higher profiles and larger canopies (e.g. shrubs and trees) will have greater capacity to intercept chemical plumes than plants with lower profiles such as forbs and grasses. All DTRA test beds may be used for collateral effects tests, with the potential for affecting plants in each respective area (the exception being LB/TS which would conduct indoor tests).

A test series was conducted at the Hazardous Spill Center at Nevada Test Site, Nevada, in which crop duster airplanes released the simulant dimethyl methylphosphonate (DMMP). A HPAC analysis was also conducted for this test. The HPAC results were comparable with the experimental results of the test series. The analytic results show a peak surface deposition of one hundred milligrams per square meter for a four hundred fifty-four kilograms release (Espander, 2005 [Appendix I]). Although the effects of DMMP on plants is not known, the amount of DMMP deposited on the surface is very small and is not expected to significantly affect flora in the test area.

After several tests using TEP, no visible changes were observed in the flora found immediately adjacent to the test structures.

The release of the chemical simulant triethyl phosphate (TEP) at PHETS was projected to cause damage to plants within a 400 m radius of the test structure: plants would turn brown but not die, and plants within 100 m of the test structure might die. However, after several tests using TEP no visible changes were observed in the flora found immediately adjacent to the test structures (FCDSWA, 1998). Selected chemical simulants including TEP, which have undergone more extensive environmental analyses, are discussed in the sections that follow.

Previous tests on WSMR indicate that small numbers of tests using TEP do not appear to have an effect on plant communities. Although thiodiglycol (TDG), and TEP break down relatively slowly when trapped in soil, photodegradation of these test materials is generally rapid. Therefore, surface deposition of simulants from air fallout will subject the materials to photodegradation before they can be incorporated into the subsurface. Although in-depth information is not available for each chemical listed, the Tennessee Valley Authority's National Fertilizer and Environmental Research Center studied the phytotoxic (plant-damaging) effects of TEP and determined that a concentration of 400 mg/m^2 is mildly phytotoxic and concentrations over 40,000 mg/m^2 are potentially fatal to vegetation (Sikora et al., 1994). It is projected that if testing occurred at full capacity using TEP in maximum amounts with no losses, it could reach a concentration of 500 mg/m^2 within 5 km (3 mi) of the impact site over the next ten years (calculated using TEP surface deposition concentration of 10^{-5} kg/m^2 per test, and adjusted for 4,000 gallons per test [FCDSWA, 1998]). Even with the unrealistic assumption of no losses, this worst-case scenario suggests that levels would only marginally reach the mild phytotoxic range.

Methyl salicylate (MeS), another chemical simulant, produces temporary phytotoxic effects at foliar deposition concentrations of $4x10^{-5}$ kg/m^2 (Cataldo et al., 1993). Although MeS is short-lived in the environment, surface depositions of MeS will likely reach this level near the impact site after a single test, but effects are expected to last only approximately two weeks (Cataldo et al., 1993). Concentrations at which other simulants produce phytotoxicity are not well studied. If phytotoxic effects are identified outside a 400-meter radius and/or fatal effects are seen outside a 100-meter radius around test structures, WS-ES will be consulted and corrective actions will be discussed.

The WSMR Integrated Training Area Management (ITAM) Program established Land Condition Trend Analysis (LCTA) data collection plots inside the PHETS boundary, in order to conduct long-term monitoring of vegetation trends. The acquired data were used to compare vegetation at PHETS to similar vegetation at undisturbed sites (control sites). Results of the analysis indicated that plant density has not been negatively affected by

testing at PHETS (U.S. Army, 2002b). No sampling events have taken place at these transects recently.

Air sampling is done as part of all collateral effects analyses involving simulants and taggants to assess and map the extent and movement of the plume. This information may be used to support a monitoring program to track the atmospheric concentration and deposition of test materials, monitor potential build-up of those materials in the soil and ground water, and determine if there is an effect on vegetation (as well as the insect and animal populations in those areas).

Rock Penetration Testing. A small amount of vegetation would be disturbed and/or destroyed as a result of rock penetrating tests and recovery operations. Areas that would be used for rock penetration testing include SHIST, Alt. SHIST, and, Capitol Peak HTD. At SHIST and Alt. SHIST, vegetative disturbance will mainly be limited to areas containing bedrock substrate. These test beds have been previously disturbed through past testing activities and would continue to be sparsely vegetated under the proposed action.

Hard Target Defeat Testing. Tests would largely involve the use of inert and/or live penetrator warheads and static explosive charges. Hardened targets include tunnel targets excavated from granite or limestone bedrock and reinforced bunkers that are buried or partially buried. Vegetation disturbance at Capitol Peak HTD test bed would mainly be limited to areas close to the tunnel targets.

Impacts to vegetation from HTD testing would be similar to rock penetration testing. Some vegetation would be damaged or destroyed from weapons impact, blast over pressure, and burning from the detonation of high explosives (especially in larger tests using devices up to 500 tons TNT equivalency). Within PHETS, tests against targets on established test beds would cause little damage to native vegetation. At the Capitol Peak HTD test bed, the greatest potential effect to flora would be from the testing of high explosives against tunnel targets. Overall, the amount of vegetation damaged or destroyed from HTD testing would likely be less than losses resulting from test bed expansion or construction. Collateral effects tests in which CBR simulants are used may be conducted in conjunction with HTD test. (Effects to vegetation from collateral effects testing are discussed in the front part of this section.)

Overall, the amount of vegetation damaged or destroyed from HTD testing would likely be less than losses resulting from test bed expansion or construction.

Advanced Weapon Lethality Testing. Various types of advanced weapon lethality testing would be conducted mainly at PHETS and the Capitol Peak HTD test bed. Unmanned aerial vehicles (UAVs), which are currently used as sensor and weapons platforms, would have minimal affect on vegetation. UAVs would typically use existing runways for takeoffs and landings resulting in no new vegetation disturbance. Some damage to vegetation may occur when weapons (delivered by UAVs) impact targets located within the DTRA test beds.

High-powered laser testing using either air- or ground-based laser systems could potentially cause wildfires, damaging some vegetation within the test bed and vicinity.

Unmanned ground vehicles (UGVs) are planned for use as sensor platforms for CBR simulant detection. These vehicles will use established roads or previously disturbed areas, minimizing damage to surrounding vegetation. UGVs may also be tested as weapons, and small amounts of vegetation would be damaged when UGVs with explosive charges engage ground targets.

Advanced energetics testing to enhance explosive power of weapons is essentially similar to other explosive tests and would potentially damage small amounts of vegetation mainly through burning.

Chemicals from non-energetic testing could potentially affect flora. These types of weapons would deploy various compounds, including abrasives and foams, to disable equipment and personnel through generally non-lethal means. These compounds could potentially harm or kill vegetation around the immediate test structure by direct contact (coating the plants).

Small amounts of vegetation would be damaged or destroyed as a result of weapons testing at DTRA test beds.

Static High Explosive (HE) Testing. Areas potentially affected by static HE testing include PHETS, LB/TS, SHIST, Alt. SHIST, and the Capitol Peak HTD test bed. Small-scale HE tests would be conducted at LB/TS facilities and no vegetation would be affected at this site. Large-scale static HE tests on the other test beds would have the greatest impact on vegetation. However, only vegetation within the immediate vicinity of the explosion would be affected. The fire department would be on call during these tests to prevent the spread of wildfires that may result.

Large Blast/Thermal Simulator Testing. Testing would be confined to within the test facility, and no negative impacts to vegetation are expected from testing at LB/TS.

Anti-Terrorism Tests. Anti-terrorism tests would occur at PHETS, primarily on the Intermediate Test Bed using the Component Test Structure 1 (CTS-1), a four-story mock-up of a typical Government Services Administration (GSA) building. Existing native vegetation around this structure has been disturbed and no new impacts on vegetation are expected through further anti-terrorism explosive testing.

Expansion of DTRA Test Beds. As usable granite and limestone bedrock test beds are used up, there will be a need for expansion into new bedrock. Proposed test bed expansion will take place at SHIST, Alt. SHIST and the Capitol Peak HTD test bed. Expanded test beds will be used for impacting weapons in newly approved areas adjacent to the existing test beds at SHIST or Alt. SHIST; or from the construction of new tunnel targets on the west side of the Capitol Peak HTD test bed and at the proposed Mockingbird South test bed. During construction activities, additional areas of vegetation would be removed or damaged by construction equipment. Additional disturbance to vegetation would result when inert and explosive weapons impact the new areas.

Most effects to vegetation from DTRA activities would be spatially limited to the DTRA test beds, which are situated in vegetation types that are common to the region.

Improvements to the PHETS Administrative Park. All planned improvement activities would take place within the existing Administrative Park, resulting in no further significant vegetation disturbance.

Discussion. Most effects to vegetation from DTRA activities would be spatially limited to the DTRA test beds, which are situated in vegetation types that are common to the region. The natural process of plant succession, in which colonizing species will establish themselves on the disturbed test beds between test events, tends to preclude permanent vegetation disturbance.

An increase in water and wind erosion would result from a loss of vegetative cover. The severity of erosion would be dependent upon amount of disturbance, soil type and steepness of slope in which the disturbance took place. It is proposed that best management practices (BMPs) designed to reduce erosion be implemented at the discretion of WS-ES. BMPs to minimize erosion may include mulching, chemical

stabilization, geotextiles, hay bale berms, silt fences, reseeding, diversion berms, gabions, etc. If required, disturbed areas may also be reseeded with native flora species approved by the WS-ES land manager.

4.2.1.2 Threatened, Endangered, or Sensitive Floral Species

WSMR has only one floral species, Todsen's pennyroyal (*Hedeoma todsenii*), federally listed as an endangered species and protected under the Endangered Species Act of 1973 (WSMR, 2001). Todsen's pennyroyal habitat occurs on steep, rugged terrain. Several populations of this species exist in the Chalk Hills and Granddaddy Peak areas of WSMR, some 40 km (25 mi) southwest of PHETS. No current or future DTRA activities are planned on or near habitat for Todsen's pennyroyal. Although there is a potential for simulant plumes to travel 30 km (17 mi) or more, prevailing winds out of the southwest are more likely to carry the plume to the northeast, away from these plant populations, making it even more unlikely that test materials will come in contact with this species. Plume movement predictions and actual test results from the DIPOLE ORBIT and DIPOLE JEWEL series demonstrate direction of travel predominately toward the east-northeast (DIPOLE ORBIT and DIPOLE JEWEL, DTRA unpublished test data, 2001).

The primary concern regarding pennyroyal populations is their small population. An Endangered Species Management Plan (ESMP) was created in accordance with Army Regulation 200-3. Management goals outlined in the ESMP include that a small buffer area be established around known pennyroyal populations, within which nearly all activities would be restricted. The ESMP also calls for searches to find additional populations of pennyroyal that may occur on WSMR. Additional management goals include monitoring activities (such as biannual estimates of pennyroyal populations), habitat monitoring, assessing potential threats, and ensuring that WSMR personnel follow policy recommendations (WSMR, 2001).

Desert night-blooming cereus listsed as State endangered (source: D.Anderson, WSMR).

Todsen's pennyroyal is the only floral species on WSMR listed as an endangered species and protected under the Endangered Species Act of 1973. No DTRA activities are planned on or near pennyroyal habitat.

There are four floral species, including Todsen's pennyroyal, listed as State endangered occurring on WSMR (Table 4-1). These plants are protected from unauthorized collection or take under the New Mexico Endangered Plant Species Act (9-10-10 NMSA

and attendant regulation 19 NMAC 21.2). All of these floral species occur within mountainous habitats away from DTRA test beds.

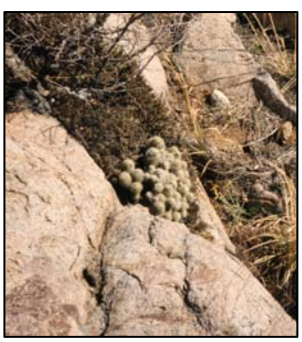
Table 4-1. Federal and State protected floral species on WSMR.

SPECIES	PROTECTION STATUS		HABITAT
	FEDERAL	STATE	
Desert night-blooming cereus *Peniocereus greggii var. greggii*	Species of Concern	Endangered	Washes or gravelly areas of Chihuahuan Desert shrublands on slopes of the San Andres Mountains.
Mescalero milkwort *Polygala rimulicola* var. *mescalerorum*	None	Endangered	Limestone cliffs of southern San Andres Mountains.
Organ Mountain pincushion cactus *Escobaria organensis*	None	Endangered	Limestone substrates in chaparral and piñon-juniper woodlands of Organ Mountains.
Todsen's pennyroyal *Hedeoma todsenii*	Endangered	Endangered	North or east facing slopes and gravelly slopes on gypsum-bearing limestone substrates in piñon-juniper woodlands of Chalk Hills in the San Andres Mountains.

Source: New Mexico Rare Plant Technical Council, 1999.

No currently listed Federal or State threatened or endangered plant species are known or expected to occur at PHETS, LB/TS, SHIST or Alt. SHIST. However, the San Andres rock daisy, (*Perityle staurophylla*), a New Mexico listed species of concern, was encountered in Capitol Canyon within the HTD test bed area during earlier survey efforts (U.S. Army, 2002a). WS–ES has been made aware of its presence in the project area. However, this species, while having State sensitive status, is afforded no special protection.

Mescalero milkwort listed as State endangered (source: D. Anderson, WSMR).



Organ Mountain pincushion cactus listed as State endangered (source: D. Anderson, WSMR).

No State and Federal species of concern (SOC) were found on DTRA test beds. State or Federal SOCs are not protected by statute or policy. They occur in mountainous habitat, away from most DTRA activities (Appendix C).

WSMR species of interest (SOI) are not specifically protected under law or regulation. Factors considered for nomination in the SOI category include scarcity on WSMR, anomalies in distribution or previous status on Federal or State lists. Although these species are not afforded legal protection, they are closely monitored by WS-ES. Most WSMR SOIs occur in mountainous habitat; however, eight SOIs occur on the basin floors (Appendix K).

Three WSMR SOIs, gramagrass cactus, pineapple cactus, and daggerthorn cholla, were found at PHETS (U.S. Army, 2002b). Gramagrass cactus (*Pediocactus papyracanthus)*, a WSMR SOI, could occur in grassland habitat near LB/TS. However, a survey conducted on 12 October 1988 did not detect gramagrass cactus (Barlow, 1988). Daggerthorn cholla (*Opuntia clavata*), a WSMR SOI, was found at SHIST Site during survey efforts (U.S. Army, 2002b).

Cory joint-fir (*Ephedra coyri*), lanceleaf beardtongue (*Penstemon ramosus*), and pineapple cactus (*Neolloydia intertexta*) are WSMR SOIs that could potentially occur in the Capitol Peak HTD area in the northern San Andres Mountains. However, the only SOI found in this area during biological surveys was pineapple cactus (U.S. Army, 2002a).

4.2.1.3 Fauna

Impacts to wildlife would be considered significant if they resulted in harm, harassment, or destruction of any endangered, threatened, or rare species, including a species proposed for listing, candidate species, or species considered sensitive. This would include impacts to designated critical habitat, migratory birds, wildlife migration corridors, or breeding areas. The loss of a substantial number of individuals of any animal species that could affect abundance or diversity of that species beyond normal variability is also considered significant. Any impacts to sensitive habitats may be considered significant.

Collateral Effects Testing Using CBR simulants. The effects of chemical, biological, and radiological (CBR) simulants and other test materials on native faunal species are largely unknown; however experiments have been performed on various model species for some of these materials. Simulants for which there are known effects on animals are summarized below.

Biological Simulants. *Bacillus subtilis* (Bg), *Bacillus thuringiensis* (BT), *Clostridium sporogenes,* MS2 bacteriophages, noninfectious influenza A, lactic dehydrogenase (LDH), oval bumin, and *Erwinia herbicola* (EH) are biological simulants planned for use in DTRA collateral effects testing.

Bg is an aerobic bacterium that commonly occurs in soils. It is closely related to *Bacillus anthracis*, the biological warfare agent that causes the disease anthrax, however, Bg is generally not pathogenic to humans, plants or animals (ENRD, 2000; Sietske de Boer & Diderichsen, 1991; ATCC, 2000; U.S. EPA, 1997). The LC_{50} for fish is greater than 400 mg/L for a 96-hour exposure, indicating low toxicity to fish. Guinea pigs exposed to

greater than $6x10^6$ spores (dermal) and greater than $2x10^6$ spores (inhalation) showed no ill effects. In rare cases, Bg has been associated with livestock abortion in which the presence of Bg has been detected in aborted fetuses of cattle. However, Bg has never been identified as the causal agent (U.S. EPA, 1997). The U.S. Environmental Protection Agency (EPA) conducted a risk assessment of Bg in which the U.S. EPA concluded that both environmental and human risks associated with Bg are small (U.S. EPA, 1997).

Bacillus thuringiensis (Bt), a common bacterium occurring in soils, is used as a biological simulant. Bt is commercially produced as an insecticide. In the Chihuahuan Desert ecosystem, pollinators of natural vegetation are often moths (e.g. the yucca moth is an obligate pollinator of yucca). Insectivorous birds and rodents are also common. There is some evidence of Bt toxicity to birds and fish (Tomlin, 1994; Swadener, 1994). Although Bt does not have the potential to buildup in the environment, it could impact populations of insects near the test bed. This could affect the supply of food for insectivorous fauna in the immediate vicinity. The concentration of Bt used in agriculture application is comparable to expected Bt surface deposition out of a simulant plume near PHETS (see discussion of Bg in Appendix F). Repeated deposition of viable Bt over a period of time may reduce the number of moths and beetles in the PHETS area, thereby possibly having an indirect effect to reproductive rates for some plants and population sizes of insectivorous animals with confined feeding areas. To avoid interfering with yucca pollination by the yucca moth it is proposed that the biological simulant Bt be excuded from use during the month of June which is the peak flowering time of soaptree yucca (*Yucca elata*).

Clostridium sporogenes is widely distributed in nature and is common in the intestines of animals. It is closely related to *C. botulinum*, the bacterium which produces the toxin that causes botulism. *C. sporogenes* does not produce a toxin and is non-pathogenic to humans or animals (ATCC, 2000; Hammonds, 2000).

MS2 bacteriophages are viruses that are obligate parasites for bacteria and are common soil biotic constituents. MS2 is widespread in nature, being present in soil, human waste, and sewage (MEOC, 2001). MS2 bacteriophage is not pathogenic to humans or animals (ATCC, 2000).

Noninfectious influenza A is a virus that has been killed and cannot infect any organism. A killed virus is not infectious and should not be able to recombine its nucleic acid with an infectious virus. There are no environmental or human hazards of killed influenza A virus (U.S. Army, 2002b; Oshima, pers. comm., 2004).

Lactic dehydrogenase (LDH) is an enzyme that helps produce energy by converting lactic acid to pyruvate during the metabolic process. It is present in almost all of the tissues in the body and becomes elevated in response to cell damage. No adverse environmental impacts have been recognized in connection with this material.

Ovalbumin is a yellow, odorless, glycoprotein solid found in egg whites. It is common in the environment and is a dietary staple for humans and other animals. No significant environmental interactions or impacts have been observed or identified for OV. No adverse environmental impacts have been recognized in connection with this material.

Erwinia herbicola (EH) is a gram-negative, rod-shaped, vegetative bacterium that is ubiquitous in nature and generally associated with soils and plants. It is not generally considered to be pathogenic or disease-causing to the plant host with which it is associated nor is it known to cause any human or animal disease. The classification and nomenclature of *E. herbicola* has changed from earlier publications through the present. This organism was initially placed in the genus *Enterobacter* and given the species name *agglomerans*. More recent changes in the nomenclature have given it the name *Pantoea agglomerans* (Wheeler et al., 2002).

Chemical Simulants. The list of chemical simulants proposed for DTRA activities is presented in Appendices E, F, G, and H. Many of these chemicals have not been tested on wild animal species but some information exists for certain mammals and fish. The following sections focus on bioaccumulation potential of these materials in the food chain.

Mammals. The effect of exposure of proposed test materials on mammalian wildlife is largely unknown but studies have tested many of these substances on laboratory species such as rats, mice, and rabbits. Table 4-2 presents the results of these experiments for selected test materials and includes LD_{50} (lethal dose 50), LC_{50} (lethal concentration 50), and other pertinent information. The LD_{50} is the dose of a chemical that kills 50% of a sample population. The LC_{50} is the concentration of a chemical that kills 50% of a sample population. LC_{50} is the measure generally used when exposure to a chemical is through inhalation by the animal, while LD_{50} is generally used when exposure is by swallowing, through skin contact, or by injection.

Table 4-2. LD_{50} Data of Selected Test Materials on Mammals.

Chemical	LD50/LC50	Animal Tested	Other
Hexachloroethane	4460 mg/kg (oral) 32 gm/kg. (skin)	Rat Rabbit	
Tributyl Phosphate	3g/kg (oral), 400-3,000mg/kg (oral)	Rat Mouse	
Phenol	317g/kg (oral) 630 mg/kg (skin), 316 mg/m3 (inh).	Rat Rabbit Rat	
Magnesium chloride	2,800 mg/kg (oral), 1,338 mg/kg (IP), 14 mg/kg (IV).	Rat Mouse Mouse	Diet containing over 2.5% exerts toxic effects in mice.
Sodium Perchlorate	2100 mg/kg (oral)	Rat	increased rates in fibrosarcomas and lymphosarcomas
bis 2 (ethylhexyl) hydrogen phosphite	11,500 mg/kg (oral), 4,500 mg/kg (skin).	Rat Rabbit	
Diethyl phthalate	8,600 mg/kg (oral).	Rat	Possible mutagen
Glyceryl tributyrate (Tributyrin)	3,200 mg/kg (oral)	Rat	carcinomas of mammary glands and leukemia in mice.
Propionic acid	2,500 mg/kg (oral), 5,100 mg/kg (oral), 500 mg/kg (skin)	Rat Mouse Rabbit	
Trimethyl phosphite	2,500-2,890 mg/kg (oral) 2,600 mg/kg (skin)	Rat Rabbit	
1-Octanethiol	2000 mg/kg(oral) > 2000 mg/kg (skin)	Rat Rabbit	
Boron	2660 mg/kg 740 mg/kg.	Rats, mice	
Potassium Perchlorate	2100 mg/kg 27675 mg/kg 35700 mg/kg	Rabbits, rat, guinea pig	
2-Mercaptoethanol	244 mg/kg (oral) 150 mg/kg. (skin)	Rat Rabbit	Possible mutagen
2-Methyl-2-propanethiol	4729 mg/kg (oral) 22,000 ppm/48 hr (inhalation) 16,500 ppm/4 hours. (inhalation)	Rat Rat Mouse	9 ppm-inflamed lung lesions, 97 ppm-mild interstitial fibrosis. 196 ppm, interstitial lung fibrosis, nephrosis in male rats
3-Mercaptopropionic acid	3450mg/kg (oral)	Rat	1g/kg LD_{min}-frog. 0.3g/kg orally pulmonary edema and death-goat.
Benzyl mercaptan	493 mg/kg. (oral) 178 ppm/4hr (inh)	Rat Mouse	

Table 4-2. (Continued).

Chemical	LD50/LC50	Animal Tested	Other
Boron trifluoride	1180 mg/m3/4hr (inhalation) 109 mg/m3/4hr hours. >1000 ppm/3hr	Rat Guinea pig Dog	Respiratory depression, hemorrhaging, WBC count change, and respiratory structural or functional change in trachea or bronchi.
Butyl mercaptan	2575 mg/kg (oral) 4020 ppm/4hrs2500 ppm/4hrs.	Rat Rat Mouse	
Butyric Acid	2mg/kg (oral) 530 uL/kg. (skin)	Rat Rabbit	May cause increase in circulating lymphocytes and neutrophils. Cell growth may be inhibited
Chlorine Trifluoride	178 ppm/1 hr (inh)	Mouse	pneumonia and severe pulmonary irritation in dogs
Methyl mercaptan	114 mg/kg. (Oral) 675 ppm /4 hrs (inh)	Rat	1,400 ppm 15 min. rat-lethargy or reversible coma
Ethyl mercaptan	682 mg/kg (oral). 4420 ppm/4hrs (inh) 2770 ppm/4hrs (inh)	Rat Rat Mouse	
Glycerol	12600 mg/kg (oral) 4090 mg/kg (oral) 27 mg/kg (oral)	Rat Mouse Rabbit	Full strength-eyes rabbit -irritation and damage.
Mercaptoacetic acid	114 mg/kg (oral) 242 mg/kg (oral) 119 mg/kg (oral) 126 mg/kg. (oral) 100 mg/kg. (IV) 145 mg/kg. (IV)	Rat Mouse Rabbit Guinea pig Rabbit Mouse	
Isopropyl mercaptan	130mg/m3/1hr (inhalation)	Mouse	
Carbon fibers and nanotubes	440 mg/kg. (IV)	Rat	
Aluminum		Rats, mice, dogs	Short-term studies on Al comp. in diet or drinking-water, minimal effects at highest doses.

<u>Birds.</u> The effect of exposure of proposed chemicals on avian wildlife is unknown, however, some of the chemicals have been tested on birds. Fuel Oil No. 2 (FO) floats on the surface of water and may coat and kill waterfowl. Glyceryl tributyrate (Tributyrin) was found to be toxic to chickens in feeding trials (USNLM, 2003). Bird species may also be affected indirectly through ingestion of contaminated insects. Biomagnification is an increase in concentration of a pollutant from one link in a food chain to another (Mader, 1996). Biomagnification of chemicals is discussed further in this section.

<u>**Fish.**</u> The effects of the proposed CBR test materials on fish and other aquatic organisms include toxic effects and the potential for bioaccumulation. Many chemical compounds, especially those with a hydrophobic component, partition easily into the lipids and lipid membranes of organisms and may bioaccumulate. If the compounds are not metabolized as fast as they are consumed, there can be significant magnification of potential toxicological effects up the food chain.

Bioaccumulation in aquatic organisms is suggested when the bioconcentration factor (BCF) is high. Bioconcentration factor is used to describe the accumulation of chemicals in aquatic organisms in contaminated environments. The BCF is the ratio of chemical concentration in the organism to that in surrounding water. Bioconcentration occurs through uptake and retention of a substance from water only, through gill membranes or other external body surfaces (EPA, 1999).

Bioaccumulation in aquatic organisms is suggested when the bioconcentration factor (BCF) is high. BCF is used to describe the accumulation of chemicals in aquatic organisms in contaminated environments. The BCF is the ratio of chemical concentration in the organism to that in surrounding water.

Test materials with a low propensity to bioaccumulate in aquatic organisms include bleach, pentaeryythrritol tetranitrate (PETN), phenol malachite green, pentafluoroethane (PFE; Halocarbon 125; Zyron 125), diisopropyl fluoro phosphate (DFP), and titanium compounds (see Appendix F).

Other compounds with low BCFs include unsymmetrical dimethyl hydrazine (UDMH) bioconcentration in aquatic organisms should be low based on an estimated BCF value of 0.1. Bioconcentration of 1-methyl-1-propanethiol are not expected to be important fate processes in aquatic systems. The BCF for 2-mercaptoethanol can be estimated to be 0.3. This BCF value suggests that 2-mercaptoethanol will not bioconcentrate significantly in aquatic organisms. No experimental values for butyl mercaptan BCFs could be found in the literature; however, a value of 1.5 can be estimated using its log octanol/water partition coefficient 2.28; therefore, no appreciable bioconcentration in fish would be expected. Butyric acid has a bioconcentration factor of 2.3 indicating that it will not significantly bioconcentrate in fish and aquatic organisms. Aquatic bioconcentration and adsorption to sediment are not expected to be important fate processes for ethyl mercaptan. Bioconcentration factors for glycerin can be estimated at 3 and 0.2, respectively, using regression-derived equations. These values indicate that bioconcentration in fish and aquatic organisms are not likely to occur to a significant

extent. An estimated BCF of 8 for isopropyl mercaptan suggests that bioconcentration in aquatic organisms is not environmentally important. Mercaptoacetic acid has an estimated BCF of 0.69 suggesting the potential for bioconcentration in aquatic organisms is low. Methyl mercaptan has an estimated BCF of 3 suggesting the potential for bioconcentration in aquatic organisms is low.

Test materials that have greater potential to bioaccumulate in aquatic organisms include cyclotrimethylenetrinitramine (RDX), 1, 3, 5 trimethylbenzene (mesitylene), bis (2-ethylhexyl) hydrogen phosphite (bis), and diethyl phthalate. Nitromethane is not expected to bioconcentrate in fish but may bioaccumulate in algae. Hexachloroethane may bioconcentrate in aquatic organisms to a moderate degree; however, due to its rapid metabolism and the low incidence of hexachloroethane in ambient waters, food chain bioaccumulation is unlikely. Hexachlorobenzene with very high BCF values is expected to bioconcentrate in aquatic organisms. BCF values in the range of 1,600 to 20,000, measured in fish, suggest that bioconcentration in aquatic organisms is very high. Table 4-3 displays BCFs for selected test materials that are expected to bioaccumulate in aquatic organisms.

Table 4-3. Test Materials Expected to Bioaccumulate in Aquatic Organisms.

Chemical	BCF	Animal Model	Other
Hexachlorobenzene	2700-4800 1600-3900	carp	10ug/l /8weeks 1ug/ml/8weeks
Boron	52-198		
3-Mercaptopropionic acid	56		bio-concentration in aquatic organisms is moderate, not high.
1-Octanethiol	930		
Diethyl phthalate	117	Bluegill Sunfish	
Cyclotrimethylenetrinitramine (RDX)	4 11	Catfish, Fathead minnow	
bis (2-ethylhexyl) hydrogen phosphite	Not given		Bioconcentration suggested, low water solubility.
1,3,5 Trimethylbenzene (mesitylene)	23-342	Carp	
Hexachloroethane	139	Aquatic organisms	

Proposed test materials that are likely to be toxic to aquatic organisms include bleach, phenol, tributyl phosphate, inhibited red fuming nitric acid (IRFNA), and methyl mercaptan (Table 4-4).

Bleach is toxic to fish: 1 ppm available chlorine is toxic to all fish, and 0.4 ppm available chlorine is toxic to game fish. Phenol is expected to be toxic to aquatic life. Diethyl phthalate may be toxic to aquatic life. Tributyl phosphate was found to be low to moderately toxic to aquatic organisms (Nakamura, 1991). Fuel Oil No. 2 is potentially toxic to freshwater ecosystems. Fuel oil will normally float on water and can cover a large surface area in stagnant pools or slow-flowing streams. If large enough, this coating can cause oxygen depletion in an aquatic system leading to fish kills. The coating action can also kill plankton, algae, and waterfowl. Ammonium nitrate is very soluble in water and can cause nutrification resulting in massive algal blooms in static waters. This may affect local species population balance in the aquatic environment.

Table 4-4. Test Materials Potentially Toxic to Aquatic Organisms.

Chemical	LD50/LC50	Animal	Other
IRFNA	pH 3.5-3.0/96 hr for nitric acid Medium lethal concentration was around pH 4.0. The fish died at a low pH (3.0-4.0)	Bluegill Rainbow trout	Toxic due to acidity
Methyl mercaptan	The no-effect level is 0.5 ppm Minimum lethal concn is 0.9 ppm Methyl mercaptan was lethal at 1 ppm . The LC100 was 0.9 mg/l and the LC0 was 0.5 mg/l. The LC100 was 1.75 mg/l and the LC0 was 0.9 mg/l LC100 was 1.2 mg/l with an LC0 of 0.7 mg/l	coastal cutthroat trout and king and silver salmon. white bass, yellow perch, bass, bluegills, King salmon silver salmon coastal cutthroat trout	Fish are highly sensitive to methyl mercaptan
Unsymmetrical Dimethyl Hydrazine	11,350 ug/L 34,000 ug/L 7,850 ug/L 40,250 ug/L 87,894 ug/L 4700 ug/L	Channel catfish Golden shiner Fathead minnow Guppy Salamanders Zooplankton	Slightly to moderately toxic
Butyric Acid	200 mg/L/24 hr	Bluegill/Sunfish	

Table 4-4. (Continued).

Chemical	LD50/LC50	Animal	Other
Glycerol	50-67 mg/L 96 hr >5000 mg/L. 96 Hr	Rainbow trout Goldfish	
Bleach	10-100 mg/l	Fish	
Phenol	10-100 mg/l	Fish	
Tributyl phosphate		Fish	Low to moderately toxic to fish
Diethyl phthalate	< 100 mg/l	Fish	

In water, IRFNA will lower the pH and may elevate nitrate levels, stimulating plankton and aquatic weed growth.

Potential long-term changes to vegetation communities due to build up of test materials in the soil around test structures and in areas of plume deposition have the potential to "cascade up" the food web to affect other organisms (Hunter and Price, 1992). There is concern about these phenomena because even small concentrations of certain substances in the environment can find their way into organisms in high enough dosages to cause problems (Mader, 1996). It is possible that test materials may impact insect populations and the animals that depend on them such as birds and bats.

Aerial Dispersion of Chemical Simulants. Proposed testing includes the use of alternative means to disperse the simulant materials and create airborne plumes. "Crop-duster" airplanes would potentially be used to release simulant materials directly onto test beds. It is possible that wildlife could be exposed to these materials released into the air. Testing has been conducted on the chemical simulant dimethyl methylphosphonate (DMMP). The Hazardous Spill Center, Nevada Test Site, Nevada, used three crop dusters to release four 454 kilograms of DMMP in a 300 m x 5500 m target area. A Hazard Prediction and Assessment Capability (HPAC) analysis was conducted for this test and the analytic results compared well with the experimental results. The analytic results show a peak surface deposition of 100 milligrams per square meter for a 454 kilograms release (for detailed information on this test refer to Appendix I) (Espander, 2005). DMMP is expected to have a low acute toxicity in animals due to high LD_{50} values (8210 mg/kg, oral, rat) of the chemical.

Rock Penetrating Weapons, HTD, and Static HE Testing. For all DTRA test beds, craters and depressions from weapons testing create a risk to animals that might enter the hole and become trapped. The recovery of bombs and missiles from these impacts often involves enlarging the original crater and, therefore, creates a larger trapping hazard to both large and small faunal species. Other potential consequences of this testing activity

include injury to fauna from flying debris or, in the case of birds, collision with either aircraft or aerial weapons. The probability that fauna will be directly hit by debris generated during testing is inherently low. Projectiles impact a small surface area and, in conjunction with the relatively low density of faunal distribution across the large area of northern WSMR, this produces a very low probability of directly hitting an individual animal.

While there is a risk to fauna from craters and flying debris generated by HE testing, the major consequences to fauna from this type of activity are the effects of airblast and associated overpressure. The range from the explosion point at which dangerous pressure occurs depends on the size of the explosion. Table 4-5 shows the distances at which animals may be injured and represent the probability of serious injury if it is tumbling across flat terrain. If an animal is protected from tumbling by a burrow or depression, the overpressure required for serious injury increases by forty percent (McMullan and Gould, 1987). The effects of noise and airblast from HE testing vary with charge size. Temporary and possibly permanent hearing loss is expected in some animals within 3 km radius of ground zero for an 8 KT test.

Large Blast/Thermal Simulator Testing. The most significant impact to fauna from testing at LB/TS would be noise and overpressure. A reasonable threshold for significant physical effects in animals appears to be about 2 kiloPascals (kPa) (0.3 psi): this is the approximate threshold for tinnitis (ringing of the ears). Environmentally significant levels of airblast at LB/TS are summarized in Table 4-5. A peak overpressure of approximately 40 kPa (6 psi) is the threshold of serious injury to small animals from tumbling. For larger animals in burrows and birds in flight, this threshold is lowered to 35 kPa (5 psi).

Table 4-5. Thresholds of Airblast Effects to Fauna.

Environmental Effect	Pressure Level	Distance from end of LB/TS
Threshold of serious injuries to small animals	40kPa (6psi)	50m (165 ft)
Threshold of injury to birds in flight	35kPa (5psi)	60m (190 ft)
Threshold of eardrum rupture to humans and animals	35kPa (5psi)	60m (190 ft)
Damage to bird eggs and hatchlings	>3kPa (0.43psi)	>530m (1750 ft)

Source: McMullan and Gould, 1988

Improvement to the PHETS Administrative Park. Noise from vehicles and general human activity may disturb local fauna. Animals will temporarily vacate the area or

retreat to burrows in response to unexpected sounds, but may become increasingly habituated and display little modification in behavior with ongoing exposure. Small mammals and reptiles may avoid unexpected noise by retreating underground, while more motile species such as birds and large mammals temporarily vacate the area (U.S. Army, 1998). Individuals of smaller, less motile, ground dwelling species (specifically reptiles, amphibians, and invertebrates) could be at some increased risk of direct injury from vehicle traffic and soil displacement during construction and reconstruction activities.

Discussion on Noise Effects. Noise affects wildlife in many ways. Noise disturbances can cause animals to abandon their home range, change their behavior, cause stress related illnesses and physiological changes, cause masking, and cause temporary hearing damage (Bowles, 1995; Manci et al., 1998). Sound is described by loudness (measured in logarithmic decibels) and in frequency sometimes referred to as pitch (measured in Hertz). Different species have varied hearing ability in certain frequencies and loudness. Nocturnal carnivores can hear 20 dB better than humans. Birds hear well in the range of 100 Hz to 8-10 kHz and most have best sensitivities around 0-10 dB. Owls are 15-20 dB more sensitive in their best range than other birds (Bowles, 1995). Reptiles as a group have more limited range than birds, from 50 Hz to 2 kHz.

Reptiles and birds are highly sensitive to vibration (Shen, 1993). Vibration sensitivity is an important source of information about approaching predators and prey. Because they have relatively insensitive hearing, reptiles may detect noise from vibrations (Bowles, 1995). Low pitches, such as gunfire, create more vibrations than higher pitches, and hence may mask signals and cues using vibration. Noise masking is caused when a species dependent on auditory cues cannot hear them due to other noise. Therefore, species are affected differently by noise loudness and pitch depending on their best range of hearing. It can be assumed that various faunal species are more sensitive to lower pitches, and louder dB, will be more affected than other species by explosive noises. Species that are dependent on hearing to avoid predators, obtaining food, and to communicate with their own species may be affected through masking (Bieber, 1998).

Not only are pitch and loudness variables, but how the sound is presented must also be considered. Loud abrupt sounds are more disruptive to wildlife than a continuous noise at a constant dB. The response to sonic booms or other sudden disturbances is similar among many species. Sudden and unfamiliar sounds usually act as an alarm and trigger a “fight or- flight” startle reaction (Moller, 1978). This sudden panic response may cause wildlife to injure themselves or their young, but this is usually the result of the noise in association with the appearance of something perceived by the animals as a pursuit threat

(such as a low-flying aircraft). Impact noise is not expected to cause more than a temporary startle-response, because the "pursuit" would not be present. Any loss or injury as a result of this startle response would be incidental, and not a population-wide effect.

Repeated exposure of noise may cause vertebrates to habituate or adapt behaviorally and physiologically (Peeke and Hertz, 1973; Borg, 1991). Aversion is lessened if animals can control or predict exposures (Bowles, 1995). However, species that frequent the DTRA test beds may acquire physiological problems, temporary hearing loss, and problems associated with masking.

Larkin (1996) reviewed the effects of noise associated with military training activities on wildlife. He looked specifically at vehicle noise; artillery, small-arms, and other blast noise; and helicopter noise. He concluded that the risk of hearing damage in wildlife is probably greater from exposure to nearby blast noise from bombs and large weapons than from long-lasting exposure to continuous noise or from muzzle blast of small-arms fire. Behavioral effects that might decrease chances of surviving and reproducing include retreat from favorable habitat near noise sources and reduction of time spent feeding with resulting energy depletion. Serious effects such as decreased reproductive success have been documented in some studies and documented to be lacking in other studies on other species. Decreased responsiveness after repeated noises is frequently observed and usually attributed to habituation.

Collateral effects tests may also result in noise and flying debris similar to effects described for construction and explosives testing. General mitigation to protect fauna and habitat includes the use of existing roads by vehicles whenever possible. Off-road travel will be limited to placements of testing infrastructure, plume tracking, and recovery activities using a single path in and out.

4.2.1.4 Threatened, Endangered, or Sensitive Faunal Species

Impacts to wildlife would be considered significant if they resulted in harm, harassment, or destruction of any endangered, threatened, or rare species, including a species proposed for listing, candidate species, or species considered sensitive.

Mammals. The desert bighorn sheep (*Ovis canadensis mexicana*), a State listed endangered species, is confined to steep and inaccessible areas of the San Andres Mountains. In November 2002, 51 desert bighorn sheep were introduced into the San Andres National Wildlife Refuge in the San Andres Mountains, the northern edge of which is located approximately 66 km (41 mi) from the Capitol Peak HTD test bed.

Although possible, it is unlikely that a sheep would wander that far north of the refuge (Morrow, pers. comm., 2004). If an animal is seen in proximity to the test bed prior to a test, WS-ES will be contacted prior to testing.

The Oscura Mountains Colorado chipmunk (*Tamias quadrivittatus oscuraensis*), listed as threatened by the State, only occurs in the Oscura Mountains. Once thought of as a population of Organ Mountains Colorado chipmunk (*T. q. australis*), it has recently been described as a separate subspecies (NMDGF, 2000). Both subspecies are listed as threatened by NMDGF. The Organ Mountains Colorado chipmunks (*T. q. australis*) are considered to be SOC by USFWS. (Throughout this section, the term "species of concern" refers to a designation used by the USFWS for planning purposes only and connotes no listing status). Populations of Colorado chipmunks in the Oscura Mountains occur between elevations of 2,370 m to 2,493 m (7,800 ft to 8,200 ft) and will not be affected by DTRA activities.

The spotted bat (*Euderma Maculatum*) is a New Mexico threatened species that may use the areas around DTRA test beds as foraging habitat. In addition, there may be roosting habitat in the area of SHIST and the Capitol Peak HTD test bed. Bats roosting in SHIST and Capitol Peak areas will either relocate as a result of disturbance or become habituated to the activity at these sites. However, the use of chemical and biological simulants may affect the insect population in DTRA test beds, thereby affecting the food source for the spotted bat and other insectivorous fauna within a 5 km radius.

White Sands pupfish (*Cyprinidon tularosa*) source: (D. Burkett, WTS, WSMR).

Fish. The potential exists for simulant plumes from collateral effects tests at the Capitol Canyon HTD test bed to drift through the air and settle out on the floor of Tularosa Basin. Surface waters in the basin are home to the White Sands pupfish (*Cyprinidon tularosa*), a New Mexico threatened species. Hazard Prediction and Assessment Capability (HPAC) analyses were run to generate plume models for simulated Bg releases from the Capitol Peak HTD test bed (Espander, 2004 and 2006 [Appendix J]). (Bg is used as a reasonable proxy for biological simulants in general). Models, using actual weather data for the region, showed Bg concentration for areas of known habitat for the White Sands pupfish downwind from the test bed (with approximate distances): Salt Creek 26 km (16 mi); Malpais Spring 16 km (10 mi), Mound Springs 10 km (6 mi), and the closest location defined as essential pupfish habitat (4.2 km [2.6 mi] from the Capitol Peak test bed) by White Sands Pupfish Cooperative Agreement (NMDGF 1994). The results indicated that

surface deposition of Bg out of an airborne plume would be between 1.0 x 10^{-11} kg/m^2 and 1.0 x 10^{-10} kg/m^2 for all four locations, with diffusion to an even smaller concentration of 1.0 x 10^{-14} kg/m^2 over short distances from these locations (Espander, 2004 and 2006 [Appendix J]). As indicated from the models run, the amount of Bg potentially entering these waters is exceedingly small. Bg would not have a significant effect on the White Sands pupfish or other biota in the area.

A similar HPAC model for a simulated dimethyl methylphosphonate (DMMP) release from the Capitol Peak HTD test bed was also generated (Espander, 2004 [Appendix J]). The model demonstrated that the DMMP plume would deposit this material on the land surface at a rate of 1.0 x 10^{-7} kg/m^2 at the following three locations; Salt Creek, Malpais Spring, and Mound Springs with diffusion to an even smaller concentration of 1.0 x 10^{-9} kg/m^2 over short distances from these locations was exhibited (Espander, 2004 [Appendix J]). Deposition to the location of the nearest essential pupfish habitat was predicted to be between 1.0 x 10^{-7} kg/m^2 and 1.0 x 10^{-6} kg/m^2 (Espander, 2006 [Appendix J]). Like the biological simulant Bg, the amount of DMMP potentially entering these waters is exceedingly small. DMMP would not have a significant effect on the White Sands pupfish or other biota in the area.

Proposed mitigations for tests that could impact pupfish habitat would include periodic sampling of the stream waters containing pupfish to assure little or no impact to aquatic life.

Birds. Until recently, the last observations made of aplomado falcons (*Falco femoralis septentrionalis*) on WSMR were in 1991 and 1992 when a single transient aplomado falcon was sighted on the east central portion of the range, near Rita and Black Sites (D. Holdermann, pers. comm., 2000). No aplomado falcons were observed from 1996 through 2002 (WSMR, 2003) during system-wide surveys conducted in accordance with the U.S. Fish and Wildlife Service Survey Methodology for the Northern Aplomado Falcon in Desert Grasslands. On 27 August 2005, during a raptor survey, a juvenile aplomado falcon was observed near Stallion Range Center which is located on the northwest portion of WSMR. This observation was reported to the U.S. Fish and Wildlife Service on 30 August 2005 in accordance with the 2003 Survey Methodology. Several years of system-wide surveys indicated that the aplomado falcon did not occur at WSMR, and no aplomado falcons were observed on follow-up surveys indicating that the juvenile falcon seen 27 August 2005 was a transient bird.

Most DTRA activities will occur within established test beds where vegetation communities are considered unsuitable as aplomado falcon habitat, thus minimizing

potential to affect falcons. Therefore, it has been determined that DTRA activities are not likely to affect the northern aplomado falcon. If DTRA plans to conduct activities in areas with suitable aplomado habitat (Young et. al.2002) they will contact WSMR's Environmental Stewardship Division to ensure compliance with the Endangered Species Act.

The bald eagle (*Haliaeetus leucocephalus*), a threatened species that has been proposed for de-listing, is primarily water-oriented with the majority of the New Mexico populations found near streams and lakes. However, there are some "dry land" areas where these eagles frequent regularly. There are no resident populations of bald eagles on WSMR. The bald eagle is described as a species passing through WSMR on migration (Kamees and Burkett, 1996). Therefore, DTRA activities will likely not affect this species.

The American peregrine falcon (*Falco peregrinus anatum*) is listed as threatened by NMDGF. This species breeds in mountainous areas and, in New Mexico, occurs mainly west of the eastern plains in migration (Hubbard, 1978). The peregrine falcon was listed as rare on WSMR, occurring mainly during its breeding months (March-August) (Kamees and Burkett, 1996).

Baird's sparrow (*Ammodramus bairdii*) is listed as threatened by the NMDGF. Baird's sparrows migrate in the eastern and extreme southern areas of New Mexico and are considered rare to uncommon (Hubbard, 1978). This species is considered a rare winter resident at the White Sands National Monument, in Doña Ana and Otero counties (NPS, 2004). On WSMR, Baird's sparrow was listed as a possible rare species occurring mainly in winter months from late October through February (Kamees and Burkett, 1996). If a Baird's sparrow is sighted in an area where DTRA testing activities are planned, these activities will be suspended while WS-ES and USFWS are consulted to determine further action.

The piping plover (*Charadrius melodus circumcinctus*) is designated as Federal threatened and New Mexico endangered. This species migrates mainly through the Mississippi Valley and along the Atlantic Coast, and it winters primarily along the Atlantic and Gulf coasts from South Carolina to Texas. In New Mexico, this bird is a rare spring (April) migrant and has been reliably reported at Bosque del Apache National Wildlife Refuge (Socorro County). Piping plovers have only been reported in New Mexico on six occasions (NMDGF, 2000) and it is unlikely that DTRA testing activities will impact this species.

Herpetofauna. The mottled rock rattlesnake (*Crotalus lepidus lepidus*) is listed as threatened by the State, however none have been documented on WSMR (D. Burkett, pers. comm., 2002).

4.2.2 Impacts of Alternative Two

The second alternative would allow DTRA activities to carry out all of the actions described in alternative one plus the addition of several chemical simulants that are considered to have higher toxicity levels than those considered under the alternative one. Many of these test materials could pose a higher risk to human health and the surrounding environment than those under alternative one. Chemicals added to the second alternative include diisopropyl fluorophosphate (DFP), 2-chloroethyl ethyl sulfide (CEES), diethyl methyl phosphonate (DEMP), diisopropyl methyl phosphonate (DIMP), and bis (2-ethylhexyl) phosphate (DEPHA). Details about alternative two simulants can be found in Appendices E, F, G, and H.

The effect on floral species from the additional simulants is expected to be similar to the alternative one with slightly higher increases in toxicity. Plants occurring nearest test beds were simulants are released will have that greatest potential to be affected. Generally, effects would include impaired growth, reduced reproductive success, or plant mortality. Soil studies conducted using diisopropyl methyl phosphonate (DIMP) show that irrigation water with a concentration of 20 ppm of DIMP had no effect for tested plants species (bean, radish, wheat, tomato, sugar beet, meadow fescue, and rose). An effect level for phytotoxicity was established at a concentration of 50 ppm. Bioconcentration from both soil and hydroponic solutions took place, with the highest concentrations in plant leaves. When applied at application rates of 1-40 mg/cm^2 severe damage occurred to tall fescue and defoliation of short needle-pine; however, new growth was initiated within 21 days after exposure (Munro et al. 1999).

Diisopropyl fluoro phosphate (DFP) has an estimated BCF of 1 suggesting that the potential for bioconcentration in aquatic organisms is low. The acute oral LD_{50} for diisopropyl fluorophosphate is 9.8 mg/kg for rabbits, 6 mg/kg for rats, and 37 mg/kg for mice. DFP has the potential to affect wildlife due to DFP’s ability to temporarily interfere with the action of cholinesterase (Bennett, 1984). Acute animal toxicity appears to be high, given the low LD_{50} values. Possible toxicity effects could arise within the animal populations with the use of DFP.

The acute oral LD_{50} of 2-Chloroethyl ethyl sulfide (CEES) found in rats was 252 mg/kg and the lowest published lethal dose (LDLo) subcutaneous found in mice was 25 mg/kg.

When tested it was found to be mutagenic and cause DNA damage in *Escherichia coli* (*E. coli*) (CEES, 1997).

The acute oral LD_{50} of Diethyl methyl phosphonate (DEMP) for mice was 2240 mg/kg. Due to the high LD_{50}, it is unlikely that the surrounding population and animals will be at risk of exposure by DEMP.

Diisopropyl methyl phosphonate (DIMP) has been tested in ducks, rats and cattle. The resulting acute LD_{50}s are 1,490 mg/kg, 826 mg/kg, and 750 mg/kg respectively. Furthermore, DIMP has a low propensity to bioaccumulate in aquatic organisms.

The acute oral and intraperitonal LD_{50} of bis (2-ethylhexyl) phosphate (DEPHA) in rats was found to be 4.94 mL/kg and 50 mg/kg. Furthermore, the BCF for DEPHA has been estimated to be 1230, this high value indicates that bioconcentration of DEPHA may occur in aquatic organisms (USNLM, 2002).

4.2.3 Impacts of the No Action Alternative

The no action alternative would allow DTRA activities to continue at approximately the current level of magnitude under existing environmental documentation until their effective expiration. The no action alternative would result in generally less impact to biological resources in the DTRA test be areas: Mockingbird South tunnel targets would not be built; and SHIST, Alt. SHIST, and Capitol Peak HTD test beds would not be expanded. There would also be fewer testing events to potentially damage plants and animals in the affected areas. Selection of this alternative would marginally reduce overall effects to biological resources compared to the proposed action.

4.2.4 Summary of Proposed Mitigations for Biological Resources

- To assess the impacts of DTRA activities on flora, Land Condition Trend Analysis (LCTA) data collection plots inside the PHETS boundaries should be sampled annually.
- During static high explosive testing the fire department would be on call to prevent the spread of wildfires.
- BMPs designed to reduce erosion would be implemented. Examples may include mulching, chemical stabilization, silt fences, reseeding, and diversion berms.

- WSMR flora SOI may be given preferential treatment as determined by WS-ES, which may include avoidance or transplanting prior to construction activities.
- To avoid interfering with yucca pollination by the yucca moth, tests requiring the use of *Bacillus thuringiensis* (Bt) will not take place during the month of June, the peak flowering time of soaptree yucca.
- To limit potential impacts, WSMR ES should be provided a list of individual strains and/or sources of all biological simulants for review, prior to each test.
- To protect fauna and habitat support vehicles should use existing roads whenever possible. Off-road travel will be limited to placement of testing infrastructure, plume tracking and recovery activities using a single path in and out.
- If a desert bighorn sheep (*Ovis canadensis mexicana*), a State listed endangered species is seen in proximity to a DTRA test bed, WS-ES will be contacted prior to testing.
- Proposed mitigations for tests that could impact pupfish (*Cyprinidon tularosa*) habitat would include periodic sampling of the stream waters containing pupfish to assure little or no impact to aquatic life.
- If a northern aplomado falcon (*Falco femoralis septentrionalis*) or the Baird's sparrow (*Ammodramus bairdii*) are sighted in an area where DTRA testing activities are planned, WS-ES will be consulted to determine further action.

4.3 Cultural Resources

Impacts resulting from the proposed action or no action alternative would be considered significant if they were to:

- Adversely impact resources eligible for the National Register of Historic Places (NRHP)
- Substantially disturb or adversely impact non-surveyed archaeological sites
- Substantially affect access to cultural resources
- Result in noncompliance with cultural resource laws and regulations

4.3.1 Impacts of the Proposed Action

The proposed action would not significantly affect archaeological resources, given certain mitigation measures are taken to ensure the least damage to known archaeological sites and historic structures.

The actions proposed by DTRA include: testing the use of new and larger amounts of CBR simulants and taggants; continued testing of existing concepts at expanded or new sites; using existing and new weapon designs; and improvement to existing test bed infrastructure. The proposed action would not significantly affect archaeological resources, given certain mitigation measures are taken to ensure the least damage to known archaeological sites and historic structures. General mitigation for protection of cultural resources includes avoidance of all known archaeological sites, and conducting archaeological surveys to identify cultural resources in previously non-surveyed areas prior to ground-disturbing activities.

The proposed tests at the Large Blast/Thermal Simulator (LB/TS) facility, located near Stallion Range Camp, are not likely to disturb nearby archaeological sites. Although 29 archaeological sites were recorded in the Stallion area during a 1986 survey, the LB/TS tests would not occur outside the designated area or be of a greater magnitude than previous tests at the LB/TS facility.

PHETS mostly lies within the boundaries of Trinity National Historic Landmark and is used for HE events, anti-terrorism tests, and tests to evaluate the effectiveness of various weapon systems against hardened targets. The proposed action to improve the PHETS Administrative Park with energy efficient pre-engineered buildings placed on concrete slabs would not disturb or destroy any archaeological resources as no additional land would be required, and previous archaeological surveys of the Park area have not identified any sites in the immediate area. The proposed new structures at the PHETS Administrative Park would be temporary, and removed at some future time, in accordance with the Memorandum of Understanding between the New Mexico Historic Preservation Division and the Department of the Army at WSMR.

Structural analyses of McDonald Ranch House concluded that it could withstand up to eight KT airblasts if specific measures are adopted to ensure its protection. Airblast from HE testing would not have an effect on ceramic or lithic artifacts.

Previous tests at PHETS have demonstrated the vulnerability of the McDonald Ranch House to HE testing. Structural analyses conducted after the MISTY PICTURE eight KT

test in 1987 concluded that the house could withstand up to eight KT airblasts if specific measures are adopted to ensure its protection. In accordance with the mitigations originally proposed in the MISTY PICTURE EA of 1987, the house will be examined prior to and following each HE test event greater than 20 tons. This examination is an on-going event for HE tests of this magnitude, implemented again at PHETS in 2002 (U.S. Army, 2002b). If the planned level or intensity of HE testing should increase, prior consultations will be held with WSMR cultural resource personnel to determine the appropriate level of increased monitoring of the McDonald Ranch house. Airblast from HE testing would not have an effect on ceramic or lithic artifacts (McMullan and Gould, 1987).

Carbon 14 (C-14) dates for surface artifact scatters are not expected to be affected by CBR simulants and taggants due to the minute concentrations of the chemicals and pretreatment of the samples prior to testing.

Collateral effects testing on DTRA test beds using CBR simulants and taggants could potentially have an effect on carbon 14 (C-14) dates for surface artifact scatters. A list of these test materials was sent to Beta Analytic, a leading age-dating laboratory, for evaluation of possible effects on radiocarbon dating of archaeological resources. The laboratory's response (Beta Analytic staff, pers. comm., 17 May 2004) indicated that the presence of carbon in the simulants and taggants could potentially affect C-14 dates. However, assuming proper pretreatment (i.e., washing) of samples prior to analysis and to the minute concentrations of test materials expected to be deposited from plumes, the effect on C-14 dates from these test materials would be negligible.

The new or expanded test beds, required to support future DTRA activities on WSMR, would be established on exposed limestone and granite bedrock outcrops to the east of the present SHIST site, on a ridgetop west of the Alt. SHIST site, on Mockingbird South, and on limestone terrain west of the present HTD test bed at Capitol Peak. Archaeological sites have been recorded in the SHIST, Alt. SHIST, Mockingbird South, and Capitol Peak HTD areas, and additional archaeological surveys will be conducted in the areas as required. These proposed test beds would have been surveyed prior to their construction, but as they would be established largely on bedrock, they would not be likely to disturb archaeological sites.

4.3.2 Impacts of Alternative Two

The alternative two impacts would be essentially the same as those of the proposed action and would not significantly impact cultural resources in the area.

4.3.3 Impacts of the No Action Alternative

The no action alternative would lessen potential damage or disturbance to archaeological sites on WSMR due to DTRA activities compared to the proposed action.

The no action alternative would result in continued testing under the current existing National Environmental Policy Act (NEPA) documentation on WSMR which will expire over time as these analyses become outdated.

4.3.4 Summary of Proposed Mitigations for Cultural Resources

- Proposed mitigation for protection of cultural resources includes avoidance of all known archaeological sites, and conducting archaeological surveys to identify cultural resources in previously non-surveyed areas prior to ground-disturbing activities.
- If the planned level or intensity of HE testing should increase, prior consultations will be held with WSMR cultural resource personnel to determine the appropriate level of increased monitoring of the McDonald Ranch house.

4.4 Present Land Use

Impacts resulting from the proposed action and alternatives would be considered significant if they were to:

- Cause major changes to existing land use
- Substantially degrade or damage the land

4.4.1 Impacts of the Proposed Action

4.4.1.1 Military Testing Programs

The proposed action is consistent with the mission of WSMR and with on-going activities currently taking place on DTRA test beds. Military testing would continue as the primary land use for these areas into the foreseeable future.

4.4.1.2 Recreation

DTRA activities under the proposed action would not significantly affect the use of WSMR for recreation. Public access throughout the installation is limited to certain activities such as hunting, occasional races or bicycle excursion tours, and biannual tours to Trinity National Historic Landmark. These activities are scheduled to ensure that military testing remain the primary mission of WSMR and would not conflict with testing

events. In the event that testing activities must be conducted during non-duty hours, Range Scheduling and WS-ES will be notified in advance to ensure that no conflicts occur. The proposed action would not significantly affect present land use.

4.4.2 Impacts of Alternative Two

Alternative two contains all the actions described in alternative one plus the addition of several chemical simulants considered to have higher toxicity levels than those considered under alternative one. Alternative two would have the same results as the selection of the proposed action with regard to the present land use: no significant affect to present land use would result from the selection of alternative two.

4.4.3 Impacts of the No Action Alternative

The no action alternative impact is essentially the same as that of the proposed action with regard to Present Land Use and would have the same results as the selection of the proposed action.

4.5 Airspace

Impacts resulting from the proposed action and alternatives would be considered significant if they were to:

- Cause a substantial increase in the demand on airspace from increased testing activity
- Cause substantial changes to the routine handling of air traffic in the region

4.5.1 Impacts of the Proposed Action

Airspace activities would not be significantly impacted due to proposed DTRA activities. The expected increased use of unmanned aerial vehicles (UAVs) on DTRA test beds would place little additional demand on WSMR airspace.

The effects of DTRA activities on airspace would increase slightly over present levels. The increased frequency of collateral effects testing allowed under the proposed action would also increase the number of sorties for air-delivered munitions against DTRA targets. There would also likely be an increase in sorties for HTD testing as more types of munitions are approved than those that were covered for early-phase testing on the

Capitol Peak HTD test bed (U.S. Army, 2002a). For advanced weapon system testing, the increased use of unmanned aerial vehicles (UAVs) on DTRA test beds is anticipated, which would place little additional demand on WSMR airspace. The range carefully manages and schedules use of airspace, and DTRA activities would not significantly affect this resource.

4.5.2 Impacts of Alternative Two

Alternative two contains all the actions described in alternative one plus the addition of several chemical simulants that are considered to have higher toxicity levels than those considered under alternative one. The selection of alternative two would have the same results as the selection of the proposed action with regard to DTRA airspace. The impacts of DTRA activities on airspace would increase slightly over present levels, however, DTRA activities would not significantly impact airspace.

4.5.3 Impacts of the No Action Alternative

The no action alternative would allow DTRA activities to continue at approximately the current level of magnitude under existing environmental documentation until their effective expiration. Selection of this alternative would marginally reduce overall effects to airspace resources compared to the proposed action.

4.6 Air Quality

Impacts resulting from the proposed action and alternatives would be considered significant if they were to:

- Release test materials in collateral effects tests that exceed acceptable or regulatory limits

- Generate persistent, long-term sources of airborne dust that exceed Federal or State regulatory limits

4.6.1 Impacts of the Proposed Action

Air quality impacts of the proposed action would not exceed State and Federal air quality standards, and activities would meet all applicable air quality regulations. Emissions would be maintained within permissible limits. Intermittent Department of Defense testing conducted by DTRA is exempt from reporting requirements under the WSMR Title V permit.

DTRA activities will meet all applicable state and federal air quality regulations and emissions will be maintained within permissible limits.

For collateral effects tests, chemical simulant plumes (comprised of a cloud of aerosol droplets) will be released into the air. Plumes will dissipate rapidly to very low concentrations before deposition. In previous tests using triethyl phosphate (TEP), surface deposition crossing the northern WSMR boundary was less than 10^{-5}kg/m^2 (DTRA, 1999). It is surmised that dispersion of other simulants would result in similar low deposition concentrations at the WSMR boundary. Biological simulant plumes will contain bacterial spores. In DIPOLE ORBIT, concentration of viable spores in the plume at the WSMR boundary was between 10 and 100 colony-forming units (CFU) at a single point. It is estimated that concentration of spores in the plume at the WSMR boundary will be comparable to concentrations used in aerial agricultural application (Appendix F: Characteristics and Properties of Test Materials).

Plume tracers and taggants are inert gases and rare earth oxides. The tracer gases sulfur hexafluoride and carbon tetrafluoride are greenhouse gases, and the EPA monitors emissions of these gases. At maximum proposed testing, contributions of these gases to total global concentrations will be insignificant (Appendix F). The rare earth oxides are powders, with permissible exposure limit (PEL) values between 3 and 5 mg/m^3. The taggant dysprosium oxide was previously used at WSMR in the DIPOLE ORBIT 3 test, where concentration in the plume was 0.01 mg/m^3 at the WSMR boundary (DIPOLE ORBIT, DTRA unpublished test data, 2001), well below established PEL values.

Proposed mitigation to ensure hazardous quanitities of test materials do not exit the range include developing prediction models before collateral effects tests, and monitoring weather conditions such as wind speed and direction. With this information a "no go" criteria will be developed for each test (See Vol. I, p. 2-7).

Rock penetration tests, hard target defeat tests, advanced weapon systems tests, static HE tests, and anti-terrorism tests affect air quality primarily from dust generation locally on the test bed.

Large-scale HE events (approximately 1 KT or larger) have the potential to loft large amounts of dust that not only affect air quality, but also have the potential to obscure photographic coverage of the event and cause damage to sensitive experiments and instrumentation. High explosive by-products would be lofted into the atmosphere, however, 97% (by weight) of these by-products consist of water, nitrogen, and carbon dioxide. The remaining 3% of compounds would occur in small, insignificant quantities.

The use of LB/TS for creating nuclear blast effects from physical means (McMullan and Gould, 1987) would generate air emissions. Nitrogen gas heated by electric heaters is anticipated to be released into the air.

Construction activities for a new test bed at Mockingbird South and improvements to the PHETS Administration Park would produce dust. A proposed mitigation would be to apply a dust suppressant when practical to minimize excessive vehicle-generated dust levels, and vegetation cover would be retained on sites wherever possible. Heavy equipment and vehicles used for construction purposes would also generate hydrocarbon emissions and raise dust. In addition to construction activities, operation of the concrete batch plant at PHETS produces substantial dust, although the plant is used only intermittently.

The consumption of petroleum-based fuels for vehicles and generators occurs frequently on DTRA test beds. Emissions would depend on fuel and engine type, and dispersion characteristics are related to factors such as altitude, atmospheric mixing characteristics, and wind speed.

4.6.2 Impacts of Alternative Two

Alternative two contains all the actions described in alternative one plus the addition of several chemical simulants that are considered to have higher toxicity levels than those considered under alternative one. Selection of this alternative would result in the same effects as described in alternative one but the additional simulants would marginally increase the overall effects to air quality compared to the proposed action. However, air quality impacts of alternative two would not exceed State and Federal air quality standards, and activities would meet all applicable air quality regulations. Emissions would be maintained within permissible limits.

4.6.3 Impacts of the No Action Alternative

The no action alternative would allow DTRA activities to continue at approximately the current level of magnitude under existing environmental documentation until their effective expiration. The no action alternative would result in generally less impact to air quality in the DTRA test bed areas. For example, there would be less test materials released for collateral effects tests and fewer explosive tests to generate dust; Mockingbird South and additional tunnel targets at the Capitol Peak HTD test bed would not be built, and SHIST, Alt. SHIST, and Capitol Peak HTD test beds would not be

expanded. Selection of this alternative would marginally reduce overall effects to air quality compared to the proposed action.

4.6.4 Summary of Proposed Mitigations for Air Quality

- Proposed mitigation to ensure hazardous quantities of test materials do not exit the range include developing prediction models before collateral effects tests, and monitoring wind speed and direction. With this information a “no go” criteria will be developed for each test.

- A proposed mitigation to minimize dust generated from construction activities would be to apply a dust suppressant when practical to minimize excessive vehicle-generated dust levels, and vegetation cover would be retained on sites wherever possible.

- To minimize blast pressures effects resulting from high explosive tests over 20,000 lbs, weather and overcast conditions should be monitored and blast predictions be verified with distant off-range measurements.

4.7 Noise and Blast

Impacts resulting from the proposed action and alternatives two would be considered significant if they were to:

- Cause substantial impacts to people and their health on WSMR and vicinity

- Result in noncompliance with noise and hearing protection regulations

- Adversely affect large numbers of wildlife species

4.7.1 Impacts of the Proposed Action

Personnel working on DTRA test beds have the potential to be exposed to noise levels above the values given in Table 3-8, and therefore are required to wear hearing protection equipment. Activities that could produce damaging levels of noise include HE and other explosive testing, and use of heavy equipment for construction or warhead recovery. If an employee's noise exposure is expected to exceed 85 dBa expressed as an 8-hour TWA the employee would be required to enroll in a hearing conservation program.

4.7.1.1 Noise from Testing Activities

The loudest noises associated with DTRA activities are related to detonation of air-delivered weapons and HE devices. A fraction-of-a-second impulse noise level for a typical HE test would expose a person to a maximum of 152 dB. This exceeds the OSHA impulse noise limit of 140 dB. (In actual practice, humans will have been evacuated to a safe distance from explosive test areas before these tests occur and thus will have reduced potential for exposure). Most mammals and birds in the vicinity of the detonation would most likely respond to these noises by temporarily leaving the area. (See Section 4.2.1.3 for a more discussion of noise effects on wildlife).

The loudest noise associated with DTRA activities are related to detonation of air-delivered weapons and HE devices.

The effects of noise and blast from HE testing vary with charge size. Hearing protection would be provided to any exposed personnel within 9.2 km (5.7 mi) of an event 1 KT or larger. For 20-ton events, personnel will wear hearing protection at the PHETS Administrative Park and other areas where noise levels are expected to exceed 140 dB. Temporary, and possibly permanent, hearing loss is expected in some animals within 3 km (2 mi) radius of ground zero for an 8 KT test.

There is a possible impact on and off of the range from blast pressures with high quantity HE testing especially during adverse weather conditions such as strong inversions. Airblast from this type of test may cause minor cosmetic damage (e.g. broken windows, and cracked plaster) to a structure. Proposed mitigations would require that weather and overcast conditions be monitored and blast predictions will be verified with distant off-range measurements when conducting HE tests over 20,000 lbs.

Aircraft used for weapons delivery or support functions would generate noise. Noise levels generated during aircraft flights depend on speed, altitude, and meteorological conditions. Most flight activities would be at a high enough altitude and a low enough frequency to generate predicted sound levels of 70 dBA (U.S. Army, 1995), which would last no longer than a few seconds as the noise source passes overhead. Table 4-6 presents noise levels for aircraft that may be used for DTRA tests of air-delivered munitions.

4.7.1.2 Noise from Construction Activities

Construction of additional tunnel targets at Mockingbird South or the expansion area at the Capitol Peak HTD test bed may require the use of explosives for excavation purposes. Blast noise is normally measured on the C-weighted scale (dBC), which is more representative of human perception of low frequency sound associated with loud noises

Table 4-6. Noise Levels Generated by Selected Aircraft.

Aircraft	Noise level exposure level (dBA)[a]
A-10	93
A-7	90
F-111	96
F-4G	102
RF-4	102
OA-37	91
F-4	102
F-16	100

[a] At a slant distance below 914 m (3,000 ft) AGL
Source: Adapted from U.S. Army (1998); attributed to U.S. Readiness Command (1993)

(such as blasting). Maximum noise levels from blasting have been reported at less than 120 dBC (BLM, 2003). Blasting can also generate localized ground vibrations. Characteristics of the blast and ground vibrations are dependent on factors such as the type of soil/rock, type of explosive, amount of explosive used, depth of explosion, and meteorological conditions (BLM, 2003). Ground vibrations from construction activities would not affect or damage private property adjacent to the range due to the distances involved.

The use of heavy equipment for test bed construction, warhead recovery, and improvements to the PHETS Administrative Park may create noise levels sufficient to damage human hearing if protection is not used. Examples of construction equipment with sound levels at or near the 85 dBA level are listed in Table 4-7. The U.S. Army requires the use of hearing protection for workers exposed to 85dBA or higher.

Table 4-7. Typical Noise Levels of Common Construction Equipment.

Equipment	Noise Level 15 m (50 ft) From Source (dBA)
Air Compressor	81
Backhoe	80
Compactor	82
Concrete Mixer	85
Concrete Pump	82
Crane, Derrick	88
Crane Mobile	83
Dozer	85
Generator	81
Grader	85
Jack Hammer	88
Loader	85
Truck	88

dBA = A-weighted decibels
Source: National Park Service, 2000.

4.7.1.3 Noise from Vehicles

Noise levels at distances of approximately 30 m (100 ft) from vehicular traffic associated with DTRA activities would be typically less than 70 dBA (Corbitt, 1989), which is equivalent to exposure when riding in a car traveling 80 kph (50 mph). Other noise generated by human activity during test preparations would generally be low-level, infrequent, and transient.

4.7.2 Impacts of Alternative Two

Alternative two would allow DTRA activities to carry out all of the actions described in alternative one plus the addition of several chemical simulants that are considered to have higher toxicity levels than those considered under alternative one. The addition of these simulants to the selection for collateral effects testing would have no significant additional affect to the noise environment.

4.7.3 Impacts of the No Action Alternative

The no action alternative would allow DTRA activities to continue at approximately the current level of magnitude under existing environmental documentation until their effective expiration. The no action alternative would result in generally less impact from noise and blast in the DTRA test bed areas: extremely large explosive events (for example, a 500-ton TNT equivalent test) would not be detonated on the Capitol Peak HTD test bed; Mockingbird South and additional tunnel targets at Capitol Peak would not be built; and SHIST, Alt. SHIST, and Capitol Peak HTD test beds would not be expanded. Selection of this alternative would marginally reduce overall effects from noise and blast compared to the proposed action.

4.8 Radiation

Impacts resulting from the proposed action and alternatives would be considered significant if they were to:

- Subject personnel or members of the public to unsafe levels of radiation
- Result in noncompliance with established radiation exposure limits and other regulations

4.8.1 Impacts of the Proposed Action

Activities under the proposed action would result in no significant impacts from ionizing or non-ionizing radiation. Identified sources of radiation will comply with rules and

regulations outlined by the U.S. Nuclear Regulatory Commission and the Army Radiation Safety Program (Army Regulation 11-9 [1999]).

Sources of ionizing radiation in program activities include instrumentation fielded for large-scale explosive testing, x-rays from high voltage radar equipment, and the testing of chemical agent detectors. These instruments may emit low-level alpha-radiation that poses little health hazard. Radiological simulant tests would not involve the use or production of ionizing radiation.

Sources of non-ionizing radiation anticipated for DTRA activities include laser guidance and tracking systems, radar guidance and tracking systems, site illumination, communication, and electro-optical countermeasures. The potential for spectral electromagnetic interference between various systems would be analyzed before each test.

Sources of non-ionizing radiation anticipated for DTRA activities include laser guidance and tracking systems, radar guidance and tracking systems, site illumination, communication, and electro-optical countermeasures.

The human and animal body is vulnerable to the output of certain lasers, and under certain circumstances, exposure can result in damage to the eye and skin. The most common biological hazard of laser radiation is laser-induced tissue damage. In this case, tissue proteins are denatured due to the temperature rise following absorption of laser energy. It is widely accepted that the human eye is almost always more vulnerable to injury than human skin (OSHA, 2005).

Personnel will comply with all safety procedures when utilizing non-ionizing sources of radiation. For safety reasons, lasers are set at maximum permissible exposure (MPE) levels, which are well below hazardous exposure levels (WSMR, 1997). Each test planning process includes the creation of a test safety plan. When lasers are included as a part of the test, appropriate PPE/eye protection is described and required.

Personnel would comply with safety procedures involving support equipment. Safety zones would be established, and clearly delineated, to exclude entry into areas of hazardous radiation.

4.8.2 Impacts of Alternative Two

Alternative two would allow DTRA activities to carry out all of the actions described in alternative one plus the addition of several chemical simulants that are considered to have higher toxicity levels than those considered under alternative one. Activities under alternative two would result in no significant impacts from ionizing or non-ionizing radiation.

4.8.3 Impacts of the No Action Alternative

The no action alternative impact would be essentially the same as that of the proposed action with regard to radiation.

4.8.4 Summary of Proposed Mitigations for Radiation

- Personnel should comply with safety procedures involving radars and other support equipment that emits non-ionizing radiation. Safety zones should be established, and clearly delineated, to exclude entry into areas of hazardous radiation.

4.9 Hazardous Materials and Hazardous Waste

Impacts resulting from the proposed action or alternatives would be considered significant if they were to:

- Cause the amount of hazardous materials/waste to exceed the capacity of satellite accumulation points (SAPs) or other authorized repositories
- Increase amounts of hazardous materials/wastes to the point of noncompliance with Federal, State, or local environmental regulations
- Use test materials that would generate waste requiring application for new permits or revision of existing permits

4.9.1 Impacts of the Proposed Action

The collection, accumulation, and packaging of hazardous wastes will be performed in accordance with WSMR Regulation 200-1 *Environmental Hazardous Waste Management* during testing and construction activities. Petroleum, oils, and lubricants (POL) are the most common wastes likely to be encountered by personnel during project activities. Although not categorized as hazardous, POL's that are picked up are tested for

hazardous constituents they may have picked up during use. Vehicles, construction equipment, generators, and fuel storage units would employ a spill containment system (e.g., drip pans) in accordance with the WSMR Spill Prevention Plan and other regulations. CBR simulants and other test materials would be used in the smallest amounts practicable so as to reduce the accumulation of hazardous wastes. Any explosives needed for construction would be stored on-site in a temporary container designed for such use.

WSMR has the capability to manage the types and amounts of hazardous wastes generated by DTRA activities. Regulated materials are stored in areas that are far removed from the public. Waste having potentially hazardous or toxic substances would be segregated and stored in approved containers for eventual disposal in a designated area. This function is facilitated through a system of closely monitored Satellite Accumulation Points (SAPs) that are distributed throughout WSMR. SAPs are located at LB/TS, PHETS, and the Capitol Peak HTD test bed.

DTRA will follow appropriate standard operating procedures (SOPs) to prevent, control and cleanup any spills and releases that might occur as a result of testing operations.

4.9.2 Impacts of Alternative Two

Alternative two would allow DTRA activities to carry out all of the actions described in alternative one plus the addition of chemical simulants that are considered to have higher toxicity levels than those considered under alternative one. As in alternative one the collection, accumulation, and packaging of hazardous wastes will be performed in accordance with WSMR Regulation 200-1 *Environmental Hazardous Waste Management* during testing and construction activities. CBR simulants and other test materials would also be used in the smallest amounts practicable so as to reduce the accumulation of hazardous wastes. Furthermore, potentially hazardous and toxic substances would be segregated and stored in approved containers for eventual disposal in a designated area. Following these regulations, SOPs and guidelines the impact of alternative two would be the same as that of the proposed action.

4.9.3 Impacts of the No Action Alternative

The no action alternative would allow DTRA activities to continue at approximately the current level of magnitude under existing environmental documentation until their effective expiration. The no action alternative would result in generally less impact from hazardous wastes and materials in the DTRA test bed areas. For example, there would be

less test materials released for collateral effects tests, fewer explosives used, and fewer vehicles and construction equipment used. Selection of this alternative would marginally reduce overall effects from hazardous wastes and materials compared to the proposed action.

4.9.4 Summary of Proposed Mitigations of Hazardous Materials and Waste

- Vehicles, construction equipment, generators, and fuel storage units would employ a spill containment system (e.g., drip pans) in accordance with the WSMR Spill Prevention Plan and other regulations.
- CBR simulants and other test materials would be used in the smallest amounts practicable so as to reduce the accumulation of hazardous wastes.

4.10 Human Health and Safety

Impacts resulting from the proposed action or alternatives would be considered significant if they were to:

- Cause injury or disease to persons on WSMR or vicinity
- Result in exposure of general public to test materials
- Result in noncompliance with AR 385-10 or other health and safety regulations

4.10.1 Impacts of the Proposed Action

DTRA activities pose little hazard to humans living in areas adjacent to WSMR. The closest DTRA test bed, LB/TS is located 2.2 miles (3.5 km) from the northern border of WSMR. Simulant releases at the LB/TS would be limited to amounts not to exceed the containment and collection capacities of this facility so that human health protection guidelines are not exceeded. Collateral effects resulting from the release of chemical and biological simulants are also evaluated at PHETS. The northern edge of PHETS is approximately 8 miles (13 km) south of the WSMR boundary. Computer models of various chemical simulant plumes show that airborne concentrations should dissipate at 2-3 miles from the source (EPA, 2004). Thus, if any of these chemical simulant were to persist beyond the borders of WSMR it would be at concentrations not considered to be harmful or cause adverse health effects in humans (see Appendix G).

Exposure data for chemical and biological simulants proposed for use by DTRA are provided in Appendix G. Lethal dose (LD_{50}), lethal concentration (LC_{50}), permissible exposure limits (PELs), as well as carcinogenicity/human toxicity data are also given.

The health hazards posed by the proposed chemical and biological simulants are discussed in detail in Appendix F. Furthermore, computer simulated plume models are also shown in Appendix F for several proposed simulants; trimethyl phosphate, 1,3,5 trimethylbenzene, inhibited red fuming nitric acid (IRFNA), boron trifluoride, butyl mercaptan, and phenol. Each of these plume models gives a predicted concentration of the chemical with distance away from the source. Along with a predicted concentration, the corresponding Emergency Response Planning Guideline (ERPG) or Temporary Emergency Exposure Limit (TEEL) is given for each of these chemical simulants. Given that the tests to be conducted are not continuous, and none of the modeled chemical simulants are expected to persist beyond the WSMR boundary, these chemical simulants are expected to have little or no impact to the surrounding human population.

To demonstrate surface deposition of a simulant, tests were conducted at the Hazardous Spill Center, Nevada Test Site, Nevada, using three crop dusters to release 454 kg of dimethyl methylphosphonate (DMMP) in a 300 m by 5500 m target area. The simulant was tracked for 55 minutes. A HPAC analysis was conducted for this test and the analytic results compared well with the experimental results. The analytic results show a peak surface deposition of 100 milligrams per square meter for a 454 kg release (Espander, 2005). Details of these tests may be found in Appendix I. The lowest observed adverse effect level (LOAEL) for DMMP is reported at 179 mg/ kg body weight/day (Rowland et al., [no date], EPA report). A 70-kg human would have to ingest over 12,000 mg of DMMP before deleterious effects are noted.

Proposed mitigation to minimize potential harm to personnel working on DTRA test beds includes training in hazard communication; Material Safety Data Sheet (MSDS) usage, confined space entry, and hazardous material (HAZMAT) spill response procedures. WSMR facilities have existing or planned procedures addressing regulated materials that require proper handling, storage, and disposal. Potential risk to the public resulting from transportation of hazardous materials used on DTRA test beds are mitigated by following Department of Transportation (DOT) regulations regarding packaging, labeling, and transport. Most of these regulations appear in the Code of Federal Regulations, Title 49 (49 CFR).

Personnel handling and contact with CBR test materials will occur mainly during test preparations, post-test evaluation, and site clean-up. Concentrated test materials are

generally eye, skin, and respiratory irritants. Personal protection equipment (PPE) will be used in accordance with MSDS recommendations by all personnel handling any of the test materials listed in appendices E, F, G, and H.

As a result of collateral effects testing, it is likely that some amount of simulant will travel beyond the WSMR boundary. In past tests the amount of TEP crossing the WSMR boundary is several orders of magnitude less than the lowest lethal concentration for inhalation of that chemical by rats (LCLo = 28,000 ppm after 6-hr. exposure). Collateral effects testing will not be a health concern for people or livestock based on the minimal exposure expected to result from test activities.

Concentrations of biological simulant plumes at the WSMR boundary are likely to be equivalent to those used in agriculture. Other test materials are likely to have dispersion characteristics similar to TEP and are not expected to cross the WSMR boundary in significant concentrations (Appendix E).

Personnel will remain in close contact with the PHETS Administrative Park, or other coordination center, through radios or cellular telephones in the event of a safety issue or the need for evacuation. Radios shall not be used in vicinity of blasting operations or explosive storage locations. Safety exclusion zones would be established around noise hazards, and personnel entering noise hazard areas will wear protective hearing equipment. Appropriate fire suppression and air conditioning equipment would be provided.

In order to produce blast pressures for testing, the LB/TS test facility uses heated nitrogen gas. Although inert, nitrogen gas could produce a hazardous working environment by displacing oxygen, all SOPs and safety precautions will be followed to ensure the safety of test personnel.

The use of heavy equipment for excavation activities associated with construction or recovery operations could present hazards to human health and safety. Personnel would be trained on safe operation of heavy equipment and wear hardhats and other appropriate PPE. Emissions from heavy equipment could also create hazardous conditions especially during the construction or reconstruction of tunnel targets. Diesel exhaust emissions from heavy equipment contain carcinogens that could cause carbon monoxide (CO) poisoning in confined spaces. Proposed mitigations to address concerns of diesel exhaust emissions include monitoring for CO, proper ventilation of work areas, and the use of proper PPE.

There are potential hazards from the possible use of explosives for blasting during HTD tunnel target construction, and use of construction equipment. Post-test evaluation of tunnel targets would create potential hazards such as falling rock, cave-ins, dust inhalation, and traversing rough terrain.

During the fiscal years (FY) 2003-2004 DTRA reported two work place accidents. WSMR overall reported 303 work place accidents during the same period. DTRA work related accidents comprised only 0.7% of the total WSMR range-wide work place accidents. With the slight increase in test activity as described in the proposed action, work place accidents are not expected to significantly increase from current rates.

A total of five vehicle accidents were reported by DTRA during the years 2003-2004, none resulting in injuries. Of these five accidents, four were caused by vehicle collisions with oryx (*Oryx gazella*). WSMR only had complete vehicle accident data for FY 04. This data showed that WSMR had a total of 40 vehicle accidents and seven were accidents involving oryx. DTRA vehicle accidents made up 7.5% of the total range-wide accidents for FY 04, with 100% being oryx related. This animal has steadily increased in population size and geographic range, thus increasing oryx/vehicle incidences. The New Mexico Department of Game and Fish (NMDGF) and WS-ES are attempting to reduce the population by hunting so that driving safety can be improved. Location of DTRA test beds within designated hunting zones is illustrated in Figure 4-1. To minimize vehicle collisions with oryx, DTRA personnel should be briefed on oryx/vehicle collisions and safety measures such as increased awareness, especially at dusk when animals frequently occur along the roadsides.

Hantavirus pulmonary syndrome (HPS) and West Nile virus are possible health concerns in the test beds. To prevent HPS, exposure to rodents and rodent feces and urine should be avoided. DTRA activities would be conducted on active test beds and facilities, reducing the risk of exposure to hantavirus from contact with rodent urine and droppings in infrequently used, enclosed structures. It is proposed that personnel avoid areas that have potential hantavirus risk until that risk has been evaluated and abated, if necessary.

Precautions taken to minimize the risk of contracting West Nile virus include avoiding areas with a high concentration of mosquitoes, wearing insect repellent, and draining standing water (Rodriguez, 2004).

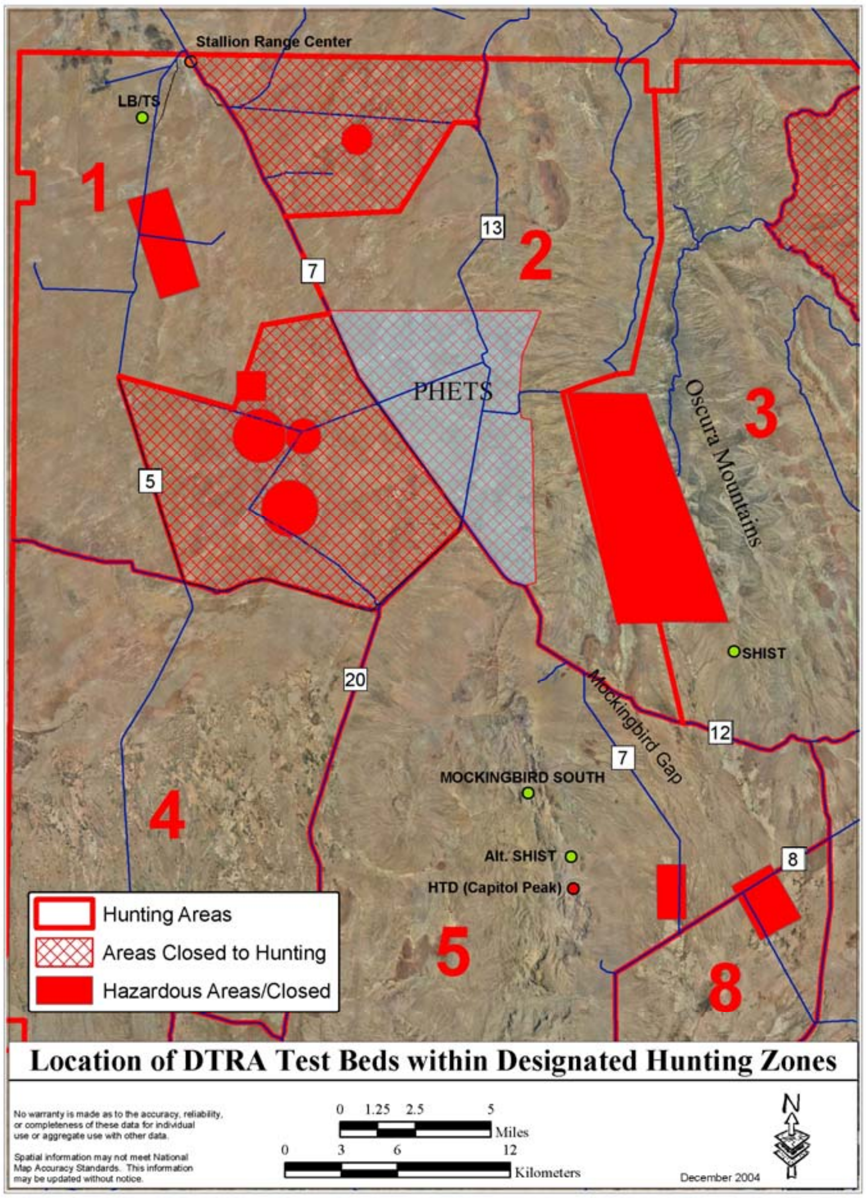


Figure 4-1. Location of DTRA test beds within designated hunting areas.

To minimize health risks from extreme desert conditions. Personnel would be briefed on desert survival and the signs of heat stroke and heat exhaustion. Personnel should be provided with adequate water and will be properly trained in first aid for heat exhaustion and heat stroke.

The possibility of personnel being bitten by venomous reptiles, spiders, or being stung by scorpions exists. Personnel should not harass or tease snakes, spiders or scorpions and contact with venomous animals and spiny plants should be avoided.

All personnel handling munitions for DTRA activities shall have explosive/ammunition certification cards on their person at all times while working on WSMR projects in accordance with ATECR 385-1. Explosive/ammunition training is required to keep personnel on top of current safety requirements, regulations, and accepted safe work practices. This training promotes and maintains a high level of safety awareness for personnel, increases technical knowledge, and teaches safe procedures and techniques necessary for safe operations with explosives, ammunition, weapon systems and explosive components.

WSMR policy requires that personnel receive unexploded ordnance (UXO) training, directing employees to remain within approved areas and not to handle unfamiliar objects. Unfamiliar objects believed to be UXO will be reported to WSMR Range Control.

4.10.2 Impacts of Alternative Two

Alternative two would allow DTRA activities to carry out all of the actions described in alternative one plus the addition of chemical simulants that are considered to have higher toxicity levels than those considered under alternative one. Chemicals added to the second alternative include diisopropyl fluorophosphate (DFP), 2-chloroethyl ethyl sulfide (CEES), diethyl methyl phosphonate (DEMP), diisopropyl methyl phosphonate (DIMP), and bis (2-ethylhexyl) phosphate (DEPHA).

Exposure to diisopropyl fluorophosphate (DFP) may occur through dermal contact with this compound at workplaces where DFP is produced or used. This is an organophosphate pesticide and is extremely toxic. Probable oral lethal dose in humans is 5-50 mg/kg, between 7 drops and 1 teaspoonful for 70 kg person (150 lb.). The material is a cholinesterase inactivator, even traces of the vapor cause pinpoint pupils (United States EPA, 1987). The utilization of PPE by test personnel will minimize the danger and

exposure to DFP. This chemical is not expected to have an impact on the general population in or around the DTRA test beds.

Exposure to 2-chloroethyl ethyl sulfide (CEES) may occur through inhalation, eye, digestive, and dermal contact with this compound at workplaces where it is produced or used. It causes severe eye and skin irritation and may cause chemical conjunctivitis and corneal damage and causes blistering of the skin. Effects may be delayed but may cause cyanosis of the extremities. If swallowed, it may cause gastrointestinal irritation with nausea, vomiting, and diarrhea. Ingestion of large amounts may cause CNS depression. When inhaled causes severe respiratory tract irritation and aspiration may lead to pulmonary edema (Acros, 2003). Risk of exposure to CEES test personnel would be minimized with use of PPE. CEES is not expected to have any impact on off-WSMR human populations.

No permissible exposure level (PEL) was found for Diethyl methyl phosphonate (DEMP) in the available literature. However, this chemical has been shown to be irritating to eyes, respiratory system and skin. No sensitizing are effects known. Organic phosphorus compounds exhibit a wide range of toxicity ranging from strong irritating properties to corrosive burns. Some organic phosphorus compounds are cholinesterase inhibitors. Symptoms associated with these include muscle twisting, convulsions, flaccid paralysis, coma, and respiratory failure (Alfa Aesar, 1999). Personnel would minimize any risk to their safety with the correct use of PPE. Due to the proximity to WSMR, the general population would likely be unaffected by the release of DEMP.

Occupational exposure to Diisopropyl methylphosphonate (DIMP) may occur through inhalation and dermal contact with this compound anywhere DIMP is produced or used. DIMP is not classifiable as a human carcinogen from the available information. EPA adapted an allowable concentration, through its Federal Drinking Water Guidelines, of 600ug/L (United States Environmental Protection Agency, 1993).

Routes of exposure for Bis (2-ethylhexyl) phosphate (DEPHA) are by ingestion, dermal, inhalation, and eye contact. DEPHA is corrosive and extremely destructive to tissues of the mucous membranes and upper respiratory tract. If ingested, it can be cause severe burns in the mouth, throat, and stomach, and vomiting, diarrhea. With the use of PPE personnel will be minimally affected. The population in and around the area will not be affected by DEPHA.

4.10.3 Impacts of the No Action Alternative

The no action alternative would allow DTRA activities to continue at approximately the current level of magnitude under existing environmental documentation until their effective expiration. The no action alternative would result in generally less impact to human health and safety in the DTRA test beds. For example, there would be less test materials released for collateral effects tests and fewer explosive tests; and Mockingbird South and additional tunnel targets at the Capitol Peak HTD test bed would not be built, and SHIST, Alt. SHIST, and Capitol Peak HTD test beds would not be expanded. Selection of this alternative would marginally reduce overall effects to human health and safety compared to the proposed action.

4.10.4 Summary of Proposed Mitigations for Human Health and Safety

- Personnel should remain in close contact with the PHETS Administrative Park, or other coordination center, through radios or cellular telephones in the event of a safety issue or the need for evacuation. Radios shall not be used in vicinity of blasting operations or explosive storage locations.
- To minimize vehicle collisions with oryx, DTRA personnel would be briefed on oryx/vehicle collisions and safety measures such as increased awareness, especially at dusk when animals frequently occur along the roadsides.
- To prevent Hantavirus pulmonary syndrome (HPS), exposure to rodents and rodent feces and urine would be avoided. It is proposed that personnel avoid areas that have potential hantavirus risk until that risk has been evaluated and abated, if necessary.
- Precautions would be taken to minimize the risk of contracting West Nile virus include avoiding areas with a high concentration of mosquitoes, wearing insect repellent, and draining standing water.
- Personnel would be briefed on desert survival and the signs of heat stroke and heat exhaustion. Personnel would be provided with adequate water and have proper training in first aid for heat exhaustion and heat stroke
- Personnel would avoid contact with venomous snakes, spiders, scorpions, and spiny plants.

4.11 Socioeconomics and Infrastructure

Impacts resulting from the proposed action and alternative two would be considered significant if they were to:

- Cause a major increase or decrease in population and/or employment levels in the region
- Substantially change the quality-of-life for persons living in the region
- Generate an unfairly high and disproportionate burden on children and minority and low-income persons living in the region
- Increase demand on public infrastructure or services that would negatively affect the quality of service for persons living in the region
- Require that major improvements to roads become necessary or new roads are needed

4.11.1 Socioeconomics

Socioeconomic Impacts of the Proposed Action. The proposed action would continue to support the DTRA mission on WSMR into the foreseeable future. Currently, the DTRA budget at WSMR is $9 million, not including government salaries. Last year, the DTRA budget totaled approximately $13 million due to a large construction effort (Fraher, pers. comm., 2004). Impacts from the proposed action would not represent a large economic boom, nor would it raise concerns regarding unwarranted, intensive new development in the northern part of WSMR. The marginal increase in scope of DTRA activities would provide an added, but relatively small, stimulus to the local and regional economies.

The marginal increase of DTRA activities would provide an added but relatively small stimulus to the local and regional economies.

The level of activity, locally and regionally, anticipated under the proposed action does not substantially differ from the current level, so changes in the economic impact to local businesses and surrounding communities would likely be minor overall. Project activities provide small, but relatively long-term, socioeconomic benefits from increased regional employment, primarily for persons living in Las Cruces, Socorro, and Alamogordo, New Mexico. Personnel working in support of DTRA activities would include military, civil servants, and contractors.

The regional center and focal point for DTRA activities on WSMR is the PHETS Administrative Park. DTRA currently comprises .009% of the WSMR-wide employee strength. Presently, there are two DTRA employees permanently assigned; approximately

40 additional personnel are on temporary assignment. Many of these workers often spend up to three nights per week in Socorro hotels. There are approximately 55 fulltime contractors, which may increase to approximately 100 during certain larger tests and construction projects. Depending upon the test or project, workers may require hotel accommodations in Socorro for up 6 months of the year. Hotel occupancy in Socorro from DTRA personnel would likely cause a minor positive benefit to the city's economy.

4.11.2 Utilities and Infrastructure

The minor employment and population impacts for the proposed action limit the potential burden to public services and infrastructure. At WSMR, the demand for installation support functions (e.g., water systems and fire protection) is not subject to extreme fluctuations, and no major changes in those demands are anticipated under the proposed action.

The current and future demand on WSMR utilities at PHETS, LB/TS, SHIST, Alt. SHIST, and the Capitol Peak HDT test bed is within existing capacity. Where hard-wired power supplies are not available, projects would rely on portable generators for power.

DTRA facilities are not connected to natural gas lines. Therefore, proposed DTRA activities would not affect natural gas demand or supplies on WSMR. Communication requirements would be accommodated by existing capabilities of the WSMR network.

Water and septic system use would increase with the improvements to the PHETS Administrative Park. A plan exists to upgrade the septic system by 50%. There would be a need for more water to be trucked in from the Stallion Range Center more frequently than at present, but the increased draw would be within the existing capacity of the Stallion well system.

4.11.3 Transportation and Circulation

The road network at WSMR has the capacity to accommodate existing traffic patterns. The transportation infrastructure would adequately handle increased traffic that may result from the proposed action. Current access to PHETS, LB/TS, SHIST, Alt. SHIST and the Capitol Peak HTD test bed is adequate to support expected future activities. During testing, roadblocks on U.S. Highway 380 and internal WSMR routes would only occasionally and temporarily disrupt the normal traffic flow (e.g., Hwy 380 is closed approximately once per year). In the future, testing activity would remain at essentially

present levels or increase slightly; however, this would cause no significant additional burden to area roads.

4.11.4 Impacts of Alternative Two

Alternative two contains all the actions described in alternative one plus the addition of chemical simulants that are considered to have higher toxicity levels than those considered under alternative one. The selection of the second alternative would have the same result as the selection of the proposed action with regard to socioeconomic relationships between WSMR and the surrounding area: the marginal increase in scope of DTRA activities would provide an added, but relatively small, stimulus to the local and regional economies with regard to employment, regional income, population, and infrastructure (including traffic circulation and utilities).

4.11.5 Impacts of the No Action Alternative

The no action alternative would allow DTRA activities to continue at approximately the current level of magnitude under existing environmental documentation until their effective expiration. The no action alternative would result in no change to the existing socioeconomic relationships between WSMR and the surrounding area. The number of Federal and civilian workers employed at WSMR would remain at approximately current levels; and there would be no change to the regional income and population. The burden on infrastructure (including traffic circulation and utilities) would be slightly less than under the proposed action.

4.12 Environmental Justice

This section identifies potential impacts the proposed action and alternatives would have on minority and/or low-income populations within the region of influence (ROI) affected by DTRA activities. This section of the PEIS assesses whether these populations might be disproportionately affected by the proposed action or alternatives. Impacts resulting from the proposed action and alternatives would be considered significant if they were to:

- Cause a disproportionately high and adverse impact to identified minority or low-income populations.
- Cause a disproportionately high and adverse environmental or human health impacts upon a minority or low-income population which appreciably exceed those of the general population.

4.12.1 Impacts of the Proposed Action

The actions proposed by DTRA include: testing the use of new and larger amounts of CBR simulants and taggants; continued testing of existing concepts at expanded or new sites; using existing and new weapon designs; and improvement to existing test bed infrastructure. Environmental and Socioeconomic Consequences of Section 4.0 show no adverse impacts to minority populations located in the ROI. There are no identifiable impacts projected to occur to off-installation populations as a direct or indirect result of the proposed action or alternatives.

EO 12898 requires identifying and addressing disproportionately high and adverse human health or environmental impacts of Federal programs, policies, and activities on minority and low-income populations. Impacts from the proposed action would not represent a large economic boom, nor would it raise concerns regarding unwarranted, intensive new development in the northern part of WSMR. The marginal increase in scope of DTRA activities would provide an added, but relatively small, stimulus to the local and regional economies but would not adversely affect minority and low-income populations.

Section 4.6 indicates that air quality impacts of the proposed action would not exceed State and Federal air quality standards. All activities would meet applicable air quality regulations and emissions would be maintained within permissible limits. Air Quality impacts from DTRA test activities would not disproportionately affect minority and/or low-income population components.

Noise producing activities associated with the proposed action (with the exception of aircraft over flights), would mainly take place at DTRA test beds located on WSMR and away from major towns and cities. In Section 4.7, noise levels generated during aircraft flights depend on speed, altitude, and meteorological conditions. Most flight activities would be at a high enough altitude and a low enough frequency to generate predicted sound levels of 70 dBA (U.S. Army, 1995), which would last no longer than a few seconds as the noise source passes overhead. It is concluded that noise generated from DTRA test activities would not disproportionately affect minority and/or low-income population when compared to the general population.

Based on the results of the impact analysis summarized in Section 4.0, Environmental and Socioeconomic Consequences it was concluded that those persons who reside in and around the DTRA ROI, including minority and/or low-income persons, would not be adversely affected by the proposed action or alternatives. No environmental or health impacts from the proposed action or alternatives would be localized or placed primarily on the identified minority and/or low-income population components. The identified

minority and/or low-income populations would not be disproportionately affected compared to the general population under the proposed action. Therefore, the proposed action would be in compliance with EO 12898.

DTRA would provide fair treatment and meaningful involvement of all people under the proposed action consistent with the goals established for environmental justice. This also includes adherence to Federal Equal Opportunity Employment laws that will not exclude persons from participation in, deny persons the benefit of, or subject persons to discrimination on the basis of race, color, religion, sex, national origin, disability or age (ref. Title VII of the Civil Rights Act of 1964; Title I and V of the Americans with Disabilities Act of 1990; Sections 501 and 505 of the Rehabilitation Act of 1973; the Equal Pay Act of 1963; and the Age Discrimination in Employment Act of 1967).

4.12.2 Impacts of Alternative Two

Alternative two impacts would be essentially the same as those of the proposed action plus the addition of chemical simulants that are considered to have higher toxicity levels. Simulant plumes generated during testing will dissipate rapidly to very low concentrations before deposition. It is surmised that dispersion of these additional simulants would result in similar low deposition concentrations at the WSMR boundary as those described in the proposed action. Impacts of alternative two would not significantly impact minority or low-income populations in the area.

4.12.3 Impacts of the No Action Alternative

The no action alternative would result in continued testing under the current existing National Environmental Policy Act (NEPA) documentation on WSMR which will expire over time as these analyses become outdated. The no action alternative would result in essentially the same impacts as compared to the proposed action and would not disproportionately affect the identified minority and/or low-income populations compared to other segments of the population.

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5.0 CUMULATIVE IMPACTS

The cumulative impacts analysis in this PEIS evaluates potential impacts associated with the DTRA proposed action (Section 2.1). Impacts of the proposed action, alternative two, and the no action alternative have been analyzed in combination with other activities occurring mainly in the northern part of WSMR where DTRA test beds are located (Figure 5-1).

Cumulative effects are the impacts on the environment that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or entity (Federal or non-Federal) or person undertakes such other actions (40 CFR 1508.7)

DTRA and one of its legacy organizations have been operating and maintaining testing sites and related infrastructure at WSMR since 1975. DTRA evaluates the lethality of chemical, biological, radiological, nuclear and high explosives, and other advanced weapons and directs the development and implementation of new weapons technologies against these targets. DTRA provides a number of testing areas and target types at WSMR for use by various DoD agencies, other U.S. Government organizations, companies and allied government experimenters. Current and future DTRA activities are described in Section 2.1.

Cumulative impacts from DTRA tests and construction activities would primarily affect natural resources such as soils, vegetation, and cultural resources. The planned expansion of test beds and construction of a new test bed (Mockingbird South) would add to the overall amount of disturbance to various natural resources. It is estimated that approximately 100 acres would be disturbed as a result of proposed expansion of DTRA test beds at SHIST, Alt. SHIST, and Capitol Peak HTD. Mockingbird South would add approximately 162 acres of further disturbance.

5.1 Activity Types and Locations

The following sections describe past, present and foreseeable future activities that have occurred or are presently occurring near DTRA test beds. These activities have been identified as having potential cumulative impacts that could add to those impacts expected from the proposed action, alternative two, and the no action alternative. These activities include private and military activities that have occurred or are presently occurring in the area.

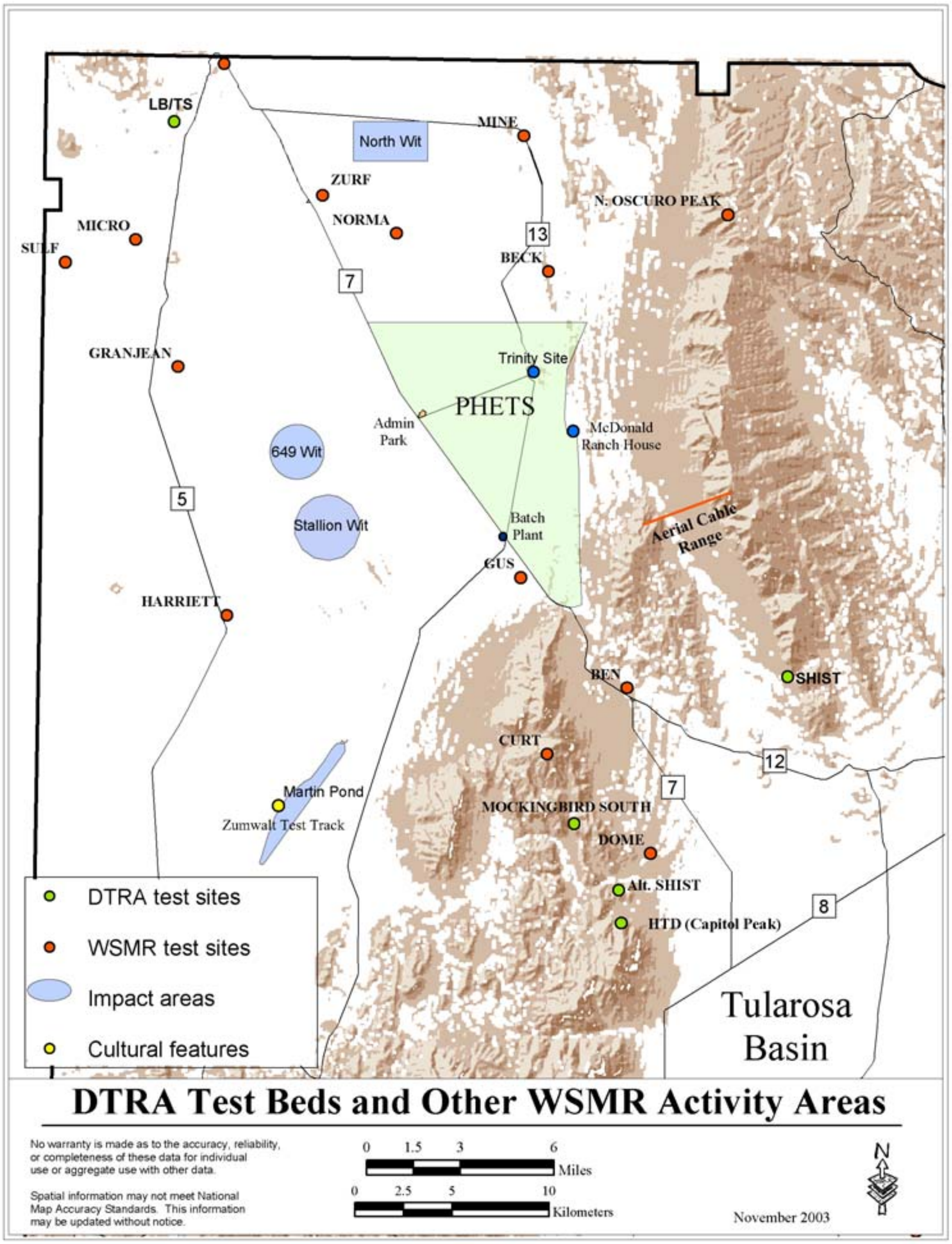

Figure 5-1. DTRA test beds and other WSMR activity areas.

The relationships of these activities on environments in the northern part of WSMR are represented in Table 5-1.

Table 5-1. Relationships of Past, Present, and Foreseeable Future Activities near the DTRA Test Beds.

Activity	Aesthetics and visual resources	Geology and soils	Water resources	Biological resources	Cultural resources	Present land use	Air space	Air quality	Noise and blast	Hazardous waste	Human health and safety	Socioeconomics and infrastructure
Past ranching and mining activities	●	●		●	●			●				
Impact areas	●	●		●	●	●	●	●	●	●	●	●
Aerial cable	●	●	●	●	●	●	●	●	●	●	●	●
Stallion Range Center	●	●	●	●	●	●	●	●	●	●	●	●
Trinity Site	●	●		●	●	●						●
Zumwalt Test Track	●	●	●	●	●	●	●	●	●	●	●	●
Launch sites	●	●		●	●	●	●	●	●	●	●	●
Military aircraft overflights				●			●	●	●		●	●
Bureau of Land Management	●	●		●	●	●		●				●

5.1.1 Past Ranching and Mining Activities

Before the U.S. military phase began with the establishment of the Alamogordo Bombing Range in 1942 and the consolidation of White Sands Proving Ground (WSPG) in 1948 (later named White Sands Missile Range in 1958), the land around the DTRA test beds was used mainly for ranching and mining. The ranching and mining period began in the 1860s and continued until 1942. A variety of metallic and non-metallic mineral deposits were mined in the area, most notably from the Mockingbird and Independence mines in the Mockingbird Mountains (Figure 5-1). With the advent of the Homestead Act of 1862 and the expansion of the cattle industry in the 1880s, the importance of ranching increased. Remnants of ranching homesteads and mines can still be seen today.

5.1.2 Impact Areas

Warhead Impact Targets (WITs) located near DTRA test beds include Stallion WIT, 649 WIT, North WIT, and NECI. Various air-to-surface and surface-to-surface test programs use these areas. Stallion and North WITs are Phase II impact areas used to test live

submunitions. The 649 WIT is a Phase I impact area used to test non-lethal submunitions. Occasionally, test programs will impact weapons systems with unitary warheads at aim points outside of established impact areas. This is allowed for unitary warheads whose impact locations can be found with certainty and are fully accounted for.

5.1.3 Aerial Cable Range

The Aerial Cable Range (ACR) is located approximately 11 km (7 mi) east of PHETS. ACR was constructed in 1992 and, as the name implies, consists of a 4,560-meter (15,000-ft) cable with a mobile target-carrying trolley suspended between two mountains. An EIS prepared for this construction project (U.S. Army, 1991) allows for up to 400 missions per year. An estimated 20 percent of these missions would involve a missile-firing operation from a ground-based launcher. The remaining 80 percent would involve items dropped from a trolley, simulating airborne delivery systems for ordnance and other materials.

5.1.4 Stallion Range Center (SRC)

Stallion Range Center (SRC) supports testing activities in the north part of WSMR with a wide range of infrastructure. SRC contains infrastructure to support test mission activities including an airstrip, maintenance shops, and meeting rooms. An electrodialysis (desalinization) plant at SRC provides potable water for the north range area (U.S. Army, 1991).

5.1.5 Trinity Site National Historic Landmark

Trinity Site is the location of the world’s first atomic bomb detonation, which took place on 16 July 1945. Trinity Site, along with McDonald ranch house where the bomb was assembled, is now part of the Trinity National Historic Landmark. Trinity Site and McDonald ranch house are open twice a year to public tours on the first Saturday of April and October.

5.1.6 Zumwalt Test Track

Zumwalt Test Track was established in 1991 as the primary test bed on WSMR for testing munitions/submunitions against moving armored tactical vehicles. The track was built to accommodate remotely operated moving targets, primarily tanks, trucks and armored personnel carriers. The track is roughly an elongate oval with an approximate road width of 14 m (45 ft) and total approximate length of 21 km (13 mi). The facility covers approximately 588 ha (1,452 ac). This test bed was initially built to facilitate

testing of the Brilliant Anti-armor (BAT) submunition but its role may be expanded for use by other programs in the foreseeable future. Additional environmental documentation may be required for future test activities conducted at Zumwalt Test Track at the discretion of the White Sands Environmental Services Office.

5.1.7 Launch Areas

Several remote launch areas exist in northern WSMR to facilitate missile and rocket firings for various surface-to-surface and surface-to-air missile test programs. Launch sites include Mine and Granjean (Figure 5-1).

5.1.8 Military Aircraft Overflights

The airspace over the Jornada del Muerto Basin is frequently used for military training. Missions typically originate from Holloman AFB to the south and from Kirtland AFB to the north. Airspace use for DTRA-related tests must be coordinated through WSMR Cox Range Control Center scheduling officer.

5.1.9 Adjacent Land Managed by the BLM

The Bureau of Land Management (BLM) manages large tracts of land west of DTRA test beds beyond WSMR boundaries. These lands are used primarily for livestock grazing and recreational activities. Presently there is no major construction activities planned on BLM lands in the area. BLM lands neighboring WSMR in Sierra County are under of the jurisdiction of the Las Cruces Field Office; the Socorro Field Office oversees BLM lands in Socorro County.

5.2 Resources Subject to Cumulative Impacts

The following section considers the cumulative effects of past, present, and reasonably foreseeable future testing on the physical, biological, and cultural resources of DTRA activities in combination with other activities, when applicable. The analysis is subdivided by environmental attribute as discussed in the affected environment sections and environmental consequences sections (Sections 3.0 and 4.0).

5.2.1 Aesthetics and Visual Resources

DTRA activities, and other past and present activities, would cumulatively alter aesthetics and visual resources. Modifications to the natural landscape have been made through construction of ranching homesteads, windmills, mines, roads, test facilities,

impact areas, and other infrastructure used by man. All of these activities and structures have changed the form and look of the natural landscape. The proposed action would also add to this visual impact with activities such as site expansion and construction of additional tunnel targets. Future actions by other, yet unidentified, entities would also add to cumulative affects on these resources. However, these test facilities and activities are located in a remote area away from WSMR boundaries and are not readily viewable to the general public. The number of viewers is primarily limited to the work force supporting activities on northern portion of WSMR. These viewers generally tend to have reduced sensitivities to potential visual impacts and are more accepting to test infrastructure and activities potentially affecting the environment. Furthermore, DTRA facilities and activities are compatible with the existing land use of WSMR.

Past and present activities including those by DTRA have had an adverse effect on visual resources in the northern portion of WSMR. The main viewers are primarily limited to the work force that is more accepting to test activities and supporting infrastructure.

5.2.2 Geology and Soils

Cumulative effects to geology and soils from DTRA activities would primarily result from test bed construction and expansion, and weapons testing. The planned expansion of test beds and construction of a new test bed (Mockingbird South) would add to the overall amount of disturbance to geology and soils. It is estimated that approximately 40 ha (100 ac) would be disturbed as a result of proposed expansion of DTRA test beds at SHIST, Alt. SHIST, and HTD. Mockingbird South would add approximately 66 hectare (ha) [162 acre (ac)] of further disturbance.

Other programs would also contribute to cumulative impacts of geology and soils with soil disturbing activities such as, road construction, trenching, construction of new test infrastructure, and impact cratering from weapons testing activities. Past livestock grazing and military activities most likely have contributed to cumulative impacts on geology and soils. These cumulative impacts would result in increased soil erosion and soil compaction.

In addition to disturbance activities there is also a potential for accumulation of unburned explosives, explosive residues, and chemical and biological test materials in the soil from collateral effects testing on DTRA test beds. Proposed soil mitigations are detailed in Section 4.1.4.1.

5.2.3 Water Resources

It is expected that the cumulative use of ground water by DTRA and other users would increase. Ground water consumed by DTRA and other programs would mainly come from the Jornada del Muerto aquifer. This ground water has high concentrations of sulfate and TDS and would mainly be used for construction purposes. Potable water for DTRA and other actions occurring in the area would come from the desalinization plant at Stallion Range Center. This desalinated water also originates from the Jornada del Muerto aquifer. It is not expected that cumulative ground water use from DTRA actions, in combination with other programs, would significantly affect ground water reserves in the Jornada del Muerto aquifer.

HE testing at PHETS could potentially contaminate ground water from unburned explosives and by-products. Most of these by-products would dissipate rapidly after a test and not reach the water table (which is relatively deep). The presence of a widespread caliche or gypsic soil horizon, and the lack of rainfall in the region would also make it unlikely that ground water would be contaminated. Proposed ground water monitoring is detailed in Section 4.1.6.1.

5.2.4 Biological Resources

Cumulative effects to biological resources (i.e., plants and animals) from DTRA and other actions would primarily result from ground disturbing activities such as construction and weapons testing. The loss of vegetation and habitat from DTRA activities would cumulatively add to present military activities as well past disturbance from ranching, mining, and military activities.

The increase in vegetation disturbance is expected to only slightly increase the amount of disturbance to vegetation and habitat for wildlife in the area. Generally, areas of past disturbance have re-vegetated and are not greatly different than surrounding vegetation.

Although there are usually apparent negative cumulative impacts resulting from ground disturbing activities, positive cumulative impacts may also result. Following ground disturbing activities, annual plant species are usually the first species to appear on site. Many of these annual plant species are favored by wildlife species as a valuable food source. For example, pronghorn antelope often favor annual forbs over existing perennial vegetation, and bird species feed on seeds produced by annual forbs. This re-vegetative process is usually short term, lasting a few years depending on precipitation, and is not considered a significant positive cumulative impact.

Vegetation may be negatively effected from collateral effects testing under the proposed action. However, impacts would primarily be concentrated near the immediate area of the test site. It is not anticipated that other actions would cumulatively add to this affect. However, a possibility remains that simulants and other test materials would build up in soil and affect vegetation. Potential long-term changes to vegetation communities due to build up of test materials in the soil around test structures and in areas of plume deposition have the potential to “cascade up” the food web to affect other organisms.

Chronic impacts could result from subtle changes in habitat and the potential for bioaccumulation (a progressive increase of the bodily content of a toxic compound) of chemicals that may be released into the environment from testing activities. Impacts to biological resources from repeated exposures close to the source can include mortality of terrestrial fauna. Tests also present a potential for acute impacts to wildlife in the vicinity from noise, blast debris, heat, and toxic materials.

The startling effect of explosions and the resulting noise can be stressful to wildlife. This reaction to stress causes physiological changes in the neural and endocrine systems, including increased blood pressure and higher levels of available glucose and corticosteroids in the bloodstream. Continued disturbances and prolonged exposure to severe stress may deplete nutrients available to the animal.

In order to measure cumulative effects in the biological resources around DTRA test beds, WSMR implemented the Integrated Training Area Management (ITAM) Program. One component of ITAM is long-term monitoring of biological resources using Land Condition Trend Analysis (LCTA) data collection plots. LCTA special use plots were set up at PHETS to provide information on the effects of DTRA testing on biological resources. As a proposed mitigation measure, data collected from these plots would be used to assess cumulative impacts of DTRA activities on flora and fauna species.

5.2.5 Cultural Resources

DTRA and other program activities have the potential to cumulatively impact cultural resources. Undiscovered cultural resources may exist that could be affected by ground-disturbing activities such as construction and testing from DTRA and other military actions. The McDonald Ranch House, an important historic structure located east of the PHETS boundary, could receive minor damage from shock waves caused by large-scale HE tests conducted by DTRA and sonic booms from military overflights.

Collateral effects testing at PHETS using simulants and other test materials were identified as potentially skewing accurate carbon 14 (C14) dates on datable cultural materials. These simulants and other test materials may accumulate in the soil and potentially affect C14 dates.

5.2.6 Present Land Use

Present land use is expected to not change significantly for the primary landowners in the region. These landholders in the affected environment include WSMR, BLM and private persons. Cattle ranching and recreation are expected to be the primary land use for BLM and private land. Military testing is expected to continue as the primary land use of WSMR. Future testing activities would not be expected to affect recreation activities such as hunting and biannual trips to Trinity National Historic Landmark. Cumulative impacts from DTRA activities, and those of landholders adjacent to WSMR, are not expected to have significant cumulative impacts to present land use.

5.2.7 Airspace

Cumulative impacts to airspace by DTRA and other actions are expected to slightly increase. The frequency of flights per year for DTRA test activities would remain essentially unchanged or increase slightly. It is not expected that the frequency of training maneuvers would significantly increase.

5.2.8 Air Quality

It is reasonable to expect that past, present and reasonably foreseeable activities would cumulatively have an impact on air quality on the north part of the range. Historic ranching on WSMR has permanently degraded some historic desert grasslands and created chronic dust problems, particularly during periods of high winds. Present grazing activities on BLM lands adjacent to WSMR may also be contributing to particulate emissions. Increased construction activity by DTRA and other programs would also increase particulate emissions. Testing activities such as missile impacts into DTRA test beds and other established impact areas would create additional particulate gaseous and toxic emissions. Established impact areas having little or no vegetative cover, and vehicle traffic on unpaved roads contribute large amounts of particulate emissions in the area. Other emissions expected to cumulatively affect air quality include aircraft overflights, explosive testing, and the use of obscurant countermeasures. Due to the transitory nature of these emissions, it is not expected that there would be accumulation over time.

5.2.9 Noise and Blast

Cumulative impacts to humans and wildlife from noise may slightly increase from DTRA and other activities. Noise sources having significant magnitude would be generated by military aircraft, sonic booms, and detonations related to military test activities. These higher magnitude noises would be infrequent and occur mainly at specific test beds or impact areas. Traffic noise may slightly increase in frequency due to increased activities by DTRA and other military testers. However, these test activities are not expected to significantly add to baseline noise levels. Noise levels to personnel working in the area may slightly increase due to increased activities by DTRA and other testers. Following guidelines set forth by OSHA and other applicable regulations would minimize these effects. High noise levels from detonations and aircraft over flights would occur on an irregular basis and cumulative noise impacts to people are not considered significant. Increased activities by DTRA and other testers would increase the noise frequency impact to wildlife. Startle effect experienced by wildlife may slightly increase with increased test activities. However, studies indicate that wildlife acclimate to noise or leave areas of high noise. Cumulative noise impacts to wildlife are not considered significant.

5.2.10 Hazardous Materials and Hazardous Waste

It is expected that hazardous materials associated with DTRA test bed construction and target demolition activities would be generated. These materials would primarily be construction materials and POL. It is also reasonable to expect that other activities would also generate additional hazardous materials, resulting in a slight cumulative increase in hazardous waste generation for combined activities. However, hazardous waste generated by construction or test activities would be recovered and disposed according to WSMR Hazardous Waste Management Plan. Program activities would not place a significant demand on hazardous waste facilities at WSMR, which are governed by WSMR Regulation 200-1. Removal of all solid waste, trash, hardware, debris, etc., would be the responsibility of the program.

5.2.11 Human Health and Safety

Cumulative health and safety impacts may increase due to an increase in DTRA and other test activities. It is expected that occupational injuries associated with test and construction activities would increase proportionally.

Exposure to hazardous materials could also be expected to increase as DTRA test activities increase. There is potential for increased exposure to hazardous materials used

in collateral effects testing. Exposure to increased noise levels is also expected as a result of increased testing activities. OSHA regulations and operational procedures would be in place to minimize work related injury and protect workers exposed to hazardous materials and increased noise levels. With these measures in place it is not expected that cumulative impacts to workers would be significant.

DTRA activities are not expected to increase the amount of unexploded ordnance (UXO) in the area. Nevertheless, personnel involved in DTRA activities would have the potential to encounter UXO. Other test groups using established impact areas could possibly add to existing UXO in the area, thus increasing the potential for personnel to exposure.

5.2.12 Socioeconomics and Infrastructure

The small increase in activities anticipated under the proposed action would likely cause a slight beneficial cumulative effect to the area economy. Activities in the area are not expected to affect population growth or impact low-income and minority populations. Cumulative impacts to public infrastructure and services would not be significant.

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6.0 UNAVOIDABLE ADVERSE EFFECTS

When analyzing the affects of alternative one no unavoidable adverse effects were identified. However, cumulative impacts analysis that evaluates the affects of an action when added to other past, present and reasonably foreseeable activities has identified that combined activities have had unavoidable adverse affects upon aesthetics and visual resources and noise.

Visual access to the northern part of WSMR is mainly limited to personnel working on the missile range. However, the general public has several opportunities to view this part of the missile range during biannual tours to Trinity National Historic Landmark, as well as during periodic hunting and biking opportunities.

The natural landscape on the northern part of the missile range has been significantly altered by 120 years of gradual but constant human activity, beginning with historic ranching and mining followed by military activities continuing into present day. Past and ongoing activities including those by DTRA have contributed to this unavoidable adverse effect.

Past and ongoing activities including those by DTRA have contributed to unavoidable adverse effects on visual resources and noise.

Historic ranching and mining activities occurring on the northern part of the range have left visible marks upon the landscape. As a result of livestock grazing some historic desert grasslands have been permanently changed to shrublands. These changes are most evident around historic livestock watering points. Old ranch structures and earthen stock tanks can still be seen today. Historic mining operations have also left a visible mark upon the landscape. Old mining structures and mine tailings can still be seen in the area.

In addition to historic ranching and mining activities, past and current military activities have made a significant visible impact upon the landscape. Military test infrastructure now appear throughout the landscape including WITs, Aerial Cable Range, Stallion Range Center (SRC), Trinity National Historic Landmark, Zumwalt Test Track, and numerous launch sites, instrumentation sites and outbuildings. DTRA has also added to this visual effect with additional buildings and test beds. Connecting this entire infrastructure is an extensive network of paved and unpaved roads adding to the visual impact within this area.

Combined noise sources generated by all activities including DTRA are expected to have a cumulative unavoidable adverse affect on the noise environment. As construction and testing activities increase, noise levels would inadvertently increase in frequency and intensity. More frequent high intensity noise levels are expected to occur with an increase in missile and bomb testing. High intensity noise levels at DTRA test beds are expected to significantly increase with the proposed testing of large explosive devices (up to approximately 500 tons TNT equivalency) at Capitol Peak or Mockingbird South HTD test beds. These increases in frequency and intensity would result in increased exposure to noise by humans and wildlife

6.1 Impacts of Alternative Two

Alternative two would allow DTRA activities to carry out all of the actions described in alternative one plus the addition of several chemical simulants that are considered to have higher toxicity levels than those considered under alternative one. Activities under alternative two would result in essentially the same unavoidable adverse effects as the proposed action.

6.2 Impacts of the No Action Alternative

Unavoidable adverse effects of the no action alternative would be essentially the same as that of the proposed action.

7.0 IRRETRIEVABLE AND IRREVERSIBLE COMMITMENT OF RESOURCES

Irreversible and irretrievable resource commitments are related to the use of nonrenewable resources and the effects the use of these resources would have on future generations. Irreversible effects would result primarily from the consumption of or destruction of a resource that could not be replaced in a reasonable period of time. Irretrievable resource commitments would involve a loss in the value of an affected resource that could not be restored. The proposed action would result in minor irreversible and irretrievable commitment of resources.

The proposed DTRA activities would result in minor long-term loss of habitat for plants or animals, insignificant loss or impact on threatened or endangered species, and insignificant loss of cultural resources such as archaeological or historic sites. Moreover, there would be no changes in land use or preclusion of development of underground mineral resources that were not already precluded.

The amount of materials and energy required for any program-related activities during the project, although relatively small, is unavoidable. Although the proposed project and program activities would result in some irretrievable commitment of resources (e.g. various metallic materials, fuel, chemicals, minerals, explosive components, construction materials used in targets, and labor), this commitment of resources is not significantly different from that necessary for many other defense research and development programs. It is similar to the activities that have been carried out in previous defense programs over the past several years. The ongoing and projected WSMR activities would not commit natural resources in unacceptable quantities. With full implementation of mitigation measures incorporated into the PEIS through the Record of Decision (ROD), adverse environmental effects would be minimized or avoided.

7.1 Impacts of Alternative Two

Alternative two would allow DTRA activities to carry out all of the actions described in alternative one plus the addition of several chemical simulants that are considered to have higher toxicity levels than those considered under alternative one. Activities under alternative two would result in minor irreversible and irretrievable commitment of resources. The consumption of chemicals used in testing may be slightly higher than the proposed action. All other use of resourses would be essentially the same as that of the proposed action.

7.2 Impacts of the No Action Alternative

The no action alternative would result in minor irreversible and irretrievable commitment of resources which would be essentially the same as that of the proposed action.

8.0 PUBLIC COMMENTS AND RESPONSES

This section contains comments received on the Draft Final PEIS during the public comment period from January 27, 2006 through March 28, 2006. All comments received have been reproduced from their original form and are included in Appendix B: Public and Regulatory Agency Comments. Responses to public comments on the Draft Final PEIS are presented in Section 8.2.

8.1 Public Comments Received on the Draft Final PEIS

The following persons or organizations provided comments on the Draft Final PEIS:

- United States Environmental Protection Agency, Region 6
- United States Department of Interior, Office of Environmental Policy and Compliance
- State of New Mexico Environment Department
- State of New Mexico Department of Game and Fish
- Private individuals

8.2 Responses to Comments Received by the Public

Comment 1 - United States Environmental Protection Agency, Region 6

Comment 1-1. EPA classified your DEIS as "LO," i.e., EPA has "Lack of Objections" to the proposed alternative. However, we have enclosed some detailed comments for your consideration in finalizing the PEIS. Our classification will be published in the Federal Register according to our responsibility under Section 309 of the Clean Air Act, to inform the public of our views on proposed Federal actions.

Response 1-1. Comment noted.

Comment 1-2. This proposed project to expand the weapons testing program at the White Sands Missile Range potentially affects multiple counties in New Mexico: Socorro, Otero, Sierra, Lincoln and Dona Ana. Although parts of Dona Ana County are in non attainment of the PM10 National Ambient Air Quality Standards (NAAQS), the designated non attainment area does not overlap with the White Sands Missile Range installation. Since the remaining counties are in attainment of all NAAQS, transportation and general conformity regulations do not apply.

Response 1-2. Comment noted.

Comment 1-3. Table 3-7 on p. 3-59 lists the criteria pollutants and contains a reference to the 1-hour ozone standard. A new 8-hour ozone standard has been promulgated by EPA and the 1-hour standard was revoked on June 15, 2005. EPA suggests adding the 8-hour ozone NAAQS of 0.08 ppm to the table.

Response 1-3. Table 3-7 on page 3-59 has been updated as indicated.

Comment 1-4. EPA has also promulgated a new particulate matter standard for fine particulate matter, $PM_{2,5}$; this standard is in addition to the existing PM_{10} standard. Please add the $PM_{2.5}$ information to complete Table 3-7: the annual $PM_{2.5}$ standard is 15 $\mu g/m^3$ and the 24-hour standard is 65 $\mu g/m^3$.

Response 1-4. Table 3-7 on page 3-59 has been updated as indicated.

Comment 2 - United States Department of the Interior

Comment 2-1. Potential impacts to threatened and endangered (T/E) plant species in the Oscura Mountains.

Response 2-1. At this time no threatened or endangered (T/E) plant species are known to exist in the Oscura Mountains on White Sands Missile Range. If any T/E plant species are discovered White Sands Environmental Office will be notified and appropriate mitigation may be implemented if needed.

Comment 2-2. Potential impacts on species associated with limestone habitat

Perityle staurophylla - NM rock daisy

Sibara grisea - Gray sibara

Thelypodopsis purpusii – Purpus tumblemustard

Response 2-2.

DTRA tunnel construction and ongoing testing activities have not affected populations of New Mexico rock daisy (*Perityle straurophylla*) located near the Capitol Canyon tunnel targets. Future DTRA activities could affect the rock daisy however impacts are expected to be minimal. Tunnel targets are constructed in Precambrian granite well below limestone outcrops the preferred habitat of the rock daisy. In addition this species is listed on State and Federal lists as a Species of Concern which is not afforded any special protection.

Gray sibara (*Sibara grisea*) is not known to occur on WSMR and will not be impacted by preferred alternative.

Known populations of purpus tumblemustard (*Thelypodopsis purpusi*) occur in the San Andres Mountains far to the south of DTRA test-beds and will not be affected by the preferred alternative.

Comment 2-3. Potential impacts to rare populations of *Polygala rimulicola* var. *mescalerorum* (Mescalero milkwort) currently limited to two small areas with less than 200 individuals in the southern part of WSMR and the San Andreas Mountains.

Response 2-3. Mescalero milkwort (*Polygala rimulicola* var. *mescalerorum*) is not known to occur near DTRA test-beds and will not be affected by the preferred alternative.

Comment 2-4. Potential impacts to *Penstomen alamosensis* (Alamo Canyon Andres beardtongue)

Response 2-4. *Penstomen alamosensis* is restricted to the southern San Andres Mountains far from DTRA activities and will not be affected by the preferred alternative.

Comment 2-5. Potential mutagenic effects of biological and chemical agents to T/E plants.

Response 2-5. Plant species listed as threatened or endangered do not occur near DTRA test beds (greater than 30 km) where simulant testing would take place. Modeling studies for DMMP a chemical simulant and Bg a biological simulant show that surface deposition levels for these simulants would be very low (less than 1.0 X 10^{-9} and 1.0 X 10^{-11} kg/m^2, respectively) if they were to travel the distance where T/E plant species occur.

Comment 2-6. Has informal consultation been conducted with the appropriate U.S. Fish and Wildlife Service, Ecological Services Field Office (ESFO)? The Threatened and Endangered species (section 4.2.1.4) addressed in the PEIS have determinations of “may affect, not likely to adversely effect,” which calls for informal consultation with FWS. A Biological Assessment (BA) or Biological Evaluation (BE) should have been completed and a concurrence letter from the ESFO included in the appendix PUBLIC AND REGULATORY AGENCY COMMENTS with the T&E list for Doña Ana, Lincoln, Otero, Sierra, and Socorro Counties, New Mexico.

Response 2-6. The northern Aplomado falcon (*Falco femoralis septentrionalis*) is being reintroduced into their historic habitat in southern New Mexico by the U.S. Fish and Wildlife Service (USFWS) for the purposes of establishing a viable resident population in New Mexico and Arizona. The species is being re-established under section 10 (j) of the Endangered Species Act of 1973 (ACT), as amended, and would be classified as a nonessential experimental population (NEP). Section 7 (a) (4) of the Act requires Federal agencies to confer (rather than consult) with the USFWS on actions that are likely to jeopardize the continued existence of a proposed species. Therefore, DTRA and WSMR have withdrawn the informal consultation previously submitted, which has a determination of “may affect, not likely to adversely affect” the falcon.

Comment 2-7. Will tests be conducted during inclement weather (i.e., inversion layer, rain, or wind)? What is the estimated amount of greenhouse gases releases (i.e., per day, month, or year)? In the PEIS it is mentioned that of some of the gases to be used in testing are not restricted; what agency provides the guidelines for the use of these gases?

Response 2-7. If inclement weather would affect test results or impacts to the local environment, testing may be delayed. Tests occurring inside facilities may or may not be delayed. The proposed mitigation to ensure CBR and HE quanitities of test materials do not exit the range include developing prediction models before collateral effects tests, and monitoring weather situations such as wind speed and direction (See Vol. I, p.2-7). With this information, a “no go” criteria will be developed for each test event. Typical criteria is an appropriate wind speed and velocity to make sure nothing will exit the range, no inversion (for large explosive events), and finally the ability to see the target to ensure no unauthorized personnel are in the area.

Green house gasses specific to DTRA test activities will vary over time depending on type and frequency of test activities. All applicable State and Federal regulations will be followed. Guidelines for the use of ”unrestricted” gasses typically come from the manufacturer in the Material Safety Data Sheet provided with the material. The content and material of an MSDS is governed through the OSHA, however there may not be a Federal or State agency that provides guidelines for those individual gasses.

Comment 2-8. During recovery efforts for craters and depressions, where will the soil for backfilling originate? Are these associated borrow pits for the backfill material on White Sands Missile Range (WSMR)? Where and how will contaminated soil be disposed? Is there current data available to analyze the impacts to soils from the current testing sites? Would testing explosions result in earth cracks in areas outside the proposed project area?

Response 2-8. Typically fill material will originate from non-contaminated material ejected from craters and depressions. However, if additional material is required, it will normally originate from borrow pits located within WSMR or be brought in from outside sources. Any contaminated soil will be disposed of in accordance with State and Federal regulations. Soil samples have been taken annually from various DTRA testbeds. In addition to a RCRA suite, samples are taken for any simulant used on the site in the previous year. Samples are usually taken after any test that disperses a simulant. Test explosions may crack the rock in the immediate vicinity of a test, but will not generate large fissures or “earth cracks”.

Comment 2-9. Have the surrounding communities been properly consulted throughout the EIS process? The PEIS does not identify that minority and/or low income communities have been consulted. How many times will flyovers occur over minority and/or low income communities (i.e., day/night or 24 hours)? Is there current data available that analyzes the vibration levels and impacts to homes (i.e., vibrating windows, cracked foundations) resulting from aircraft flyovers?

Response 2-9. All persons in the surrounding communities were invited to participate and publicly comment during the EIS process during appropriate public outreach activities (e.g. public scoping meetings). All test related flights will occur within WSMR restricted airspace and will adhere to FAA regulations concerning flight altitudes in the vicinity of populated areas. There are no identifiable impacts projected to occur to off-installation populations as a direct or indirect result of the proposed action or alternatives. No adverse or disproportionate impacts are expected to occur on minority and/or low income populations in comparison to the general population located in the ROI.

Comment 2-10. In general, it is evident that the proposed alternative and alternative two will have the potential to result in moderate to severe impacts to all resources on the WSMR. We recommend that data be collected annually, throughout the life of this ten (10) year PEIS to accurately assess cumulative effects to resources.

Response 2-10. Collection of data is proposed under the preferred alternative for the following resources; soils and vegetation at PHETS, ground water at PHETS, storm water at Capitol Peak Testbed, and annual sampling of pupfish water sources. These data will be used to assess cumulative impacts.

Comment 3 - State of New Mexico Environment Department

Comment 3-1. The U.S. Environmental Protection Agency (USEPA) requires National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) coverage for storm water discharges from construction projects (common plans of development) that will result in the disturbance (or re-disturbance) of one or more acres, including expansions, of total land area. It appears that several discrete areas may exceed one acre (including staging areas, etc.), and will therefore require appropriate NPDES permit coverage prior to beginning construction (small, one-five acre, construction projects may be able to qualify for a waiver in lieu of permit coverage – see Appendix D). In addition, since these areas are grouped under one project and Environmental Assessment, this may represent a common plan of development, and thus the entire project may require permit coverage.

Among other things, this permit requires a Storm Water Pollution Prevention Plan (SWPPP) be prepared for the site and appropriate Best Management Practices (BMPs) be installed and maintained during and after construction to prevent, to the extent practicable, pollutants (primarily sediment, oil & grease and construction materials from construction sites) in storm water runoff from entering waters of the U.S. This permit also requires that permanent stabilization measures (revegetation, paving, etc.) and permanent storm water management measures (storm water detention/retention structures, velocity dissipation devices, etc.) be implemented post construction to minimize, in the long term, pollutants in storm water runoff from entering these waters. In addition, permittees must ensure that there is no increase in sediment yield and flow velocity from the construction site (both during and after construction) compared to pre-construction, undisturbed conditions (see Subpart 9.C.1).

You should also be aware that EPA requires all "operators" (see Appendix A) obtain NPDES permit coverage for construction projects. Generally, this means that at least two parties will require permit coverage. The owner/developer of this construction project who has operational control over project specifications (probably WSMR in this case) the general contractor(s) who has day-to-day operational control of those activities at the site, which are necessary to ensure compliance with the storm water pollution plan and other conditions, and possibly other "operators" will require appropriate NPDES permit coverage for this project.

Response 3-1. WSMR is aware of the Construction General Permit and its requirements. WSMR will ensure that any construction activities that operate on the range obtain and comply with the appropriate permits.

Comment 3-2. In addition, operation of these types of facilities may require Storm Water Multi-sector General Permit (see Federal Register/Vol.65, No. 210/Monday, October 30, 2000) coverage. Impact areas, fueling and material handling areas, soil remediation activities, etc. likely qualify as potential sources of pollution which may reasonably be expected to affect the quality of storm water discharges, from activities that meet the USEPA definition of "industrial activities" under Sector K and/or L, and possibly other sectors. This permit also requires preparation of a SWPPP, and installation of appropriate storm water runoff control practices (per the SWPPP).

Although there appears to be little potential to discharge pollutants to "waters of the United States" from the proposed activities, WSMR already has NPDES Storm Water Multi-sector General Permit coverage (NMR05A057) for various other industrial activities at this facility. The permittee should amend the existing Storm Water Pollution Prevention Plan to incorporate any additional activities and pollutant controls dictated by this proposed action.

Response 3-2. Federal and State regulations will be followed when applicable. WSMR does not have any Waters of the U.S. and has sovereign immunity from state regulation of waters that are not Waters of the U.S.

Comment 3-3. Ground water in the proposed testing area is protected under the Water Quality Control Commission **(**WQCC) Regulations due to TDS concentrations less than 10,000mg/l. Given data suggesting that constituents (petroleum hydrocarbons) released from prior tests may have migrated to ground water and the potentially significant volumes of simulants that may be released to the environment during future tests, DTRA testing activities at WSMR must be conducted pursuant to a ground water discharge permit issued by NMED. A complete discharge permit application should be prepared and submitted to the Department's Ground Water Quality Bureau (GWQB) for review. In addition to contaminant releases from testing activities, domestic water discharges from the administrative complex should also be addressed in the discharge permit application so that domestic waste discharges may be included in a discharge permit.

Response 3-3. WSMR will continue to ensure that activities on the range are consistent with good stewardship of the environment and that the appropriate safeguards for protecting the groundwater are followed as Best Management Practices.

Comment 3-4. Execution of the project (construction activities at the administrative complex: construction of weapon targets and test beds) will involve the use of heavy equipment, thereby leading to the possibility of contaminant releases (e.g., fuel, hydraulic

fluid, etc.) associated with equipment malfunctions. The GWQB advises all parties involved in the project to be aware of discharge notification requirement contained in Section 20.6.2.1203 NMAC. Compliance with the notification and response requirements will ensure the protection of ground water quality in the vicinity of the project.

Response 3-4. WSMR is not required to obtain GWDPs because ther are no Waters of the U.S. on WSMR. WSMR has sovern immunity from state regulation of waters that are not Waters of the U.S.

Comment 3-5. When test weapons impact on-site, as expected, the White Sands Missile Range (WSMR) is exempt from RCRA. However, if WSMR manages the crash sites and contaminated soil, as required by their Stewardship program, then WSMR's remediation and recovery efforts may be subject to RCRA Subtitle C and/or D. Management of contaminated media and newly created waste associated with crash debris and contaminated soil is potentially subject to RCRA.

Response 3-5. Comment noted. WSMR will follow all applicable Federal and State regulations in regards to contaminated soil and crash debris.

Comment 3-6. If a test weapon crashes off-site, then WSMR is subject to the Military Munitions Rule (see Subpart M to 40 CFR 265). This scenario is not addressed in the DPEIS.

Response 3-6. You are correct that a military munition may become a solid or hazardous waste according to the Military Munitions Rule in Subpart M, of 40 CFR Part 266. Depending on circumstances of an unanticipated impact outside of WSMR boundaries, the response will either be handled as a military munition or a solid or hazardous waste response. In either event, the appropriate laws and regulations will be followed.

Comment 3-7. Nitrate concentrations have already exceeded Safe Drinking Water Act Standards and the Water Quality Control Commission (WQCC) standards in monitoring well MW-01-3 and many of the materials (high explosives and propellants) used in the tests are sources of nitrogen. If a test weapon crashes on-site in the aquifer recharge zone, then WSMR may be subject to WQCC and/or Drinking Water Regulations.

Response 3-7. Annual samples from existing monitoring wells will continue to be sampled for nitrates. All applicable regulations will be followed.

Comment 3-8. Further information is needed to determine if air quality impacts would result from the proposed project.

These activities are exempt from New Mexico air quality permitting requirements in accordance with 20.2.72.202.A.5 NMAC, which states that "Government military activities such as field exercises, explosions, weapons testing and demolition to the extent that such activities (a) do not result in visible emissions entering publicly accessible areas; (b) are not subject to New Source Performance Standards (NSPS) or National Emissions Standards for Hazardous Air Pollutants (NESHAP)". There are substances in Appendix F that are listed under 20.2.72.502 NMAC-Toxic Air Pollutants and Emissions, Table A-Noncarcinogens.

Due to lack of information provided in the DPEIS and to ensure compliance with the State of New Mexico's air ambient regulations, modeling may need to be conducted to show that the eight-hour average of the occupational exposure limit (OEL) and the required air toxic emissions limits listed under Section 502, Table A are not exceeded. If the OEL and/or the emissions limits exceed what is listed under Section 502, Table A, then an air quality permit must be obtained from the Department's Air Quality Bureau (AQB). For more information on the permitting and modeling requirements for toxic air pollutants, please refer to 20.2.72.400 NMAC.

Response 3-8. Mitigations for Air Quality (4-60) include developing prediction models before collateral effects testing, and monitoring weather situations such as wind speed and direction (See Vol 1, p. 2-7). Air monitoring and a "no go" criteria will be done on a case by case basis according to state and federal permits. During pretest modeling if any listed toxic air pollutants and emissions exceed the 8-hour occupational exposure limit (OEL), test amounts would be adjusted or present permits would be modified to remain in compliance. Prior to testing PW-EE-C will be notified of the type of test material to be used which will then be included in the WSMR air quality report to NMED.

Comment 3-9. There should be no long-term significant impacts to ambient air quality.

Response 3-9. Comment noted.

Comment 4: State of New Mexico Department of Game and Fish

Comment 4-1. The Department is primarily concerned with the potential effects of the exploded biological and chemical and radiological weapons plumes on the State-Threatened White Sands Pupfish (*Cypinodon tularosa*), which occurs in four locations in the Tularosa basin on White Sands Missile Range and Holloman Air Force Base. On 30 January, 2002, we recommended on a similar project for the Permanent High Explosives and Bedrock Penetration Test Sites Programmatic Environmental Assessment, where we

voiced concerned about the potential affects of exploded simulant plumes on the White Sands Pupfish (WSP) and the Desert Bighorn Sheep (*Ovis canadensis mexicana*). We have attached those comments for your reference.

Response 4-1. Comments noted.

Comment 4-2. Regarding our similar, but heightened concerns for the proposed project, page 4-47 of Volume I states:

The potential exists for simulant plumes from collateral effects tests at the Capitol Canyon HTD test bed to drift through the air and settle out on the floor of Tularosa Basin. Surface waters in the basin are home to the White Sands pupfish (*Cyprinidon tularosa*), a New Mexico endangered species. A Hazard Prediction and Assessment Capability (HPAC) analysis was run to generate a plume model for a simulated Bg release from the Capitol Peak HTD test bed (Espander, 2004 [Appendix J]). (Bg is used as a reasonable proxy for biological simulants in general). The model, using actual weather data for the region, showed Bg concentration and extent for three areas of known habitat for the White Sands pupfish downwind from the test bed (with approximate distances): Salt Creek 26 km (16 mi); Malpais Spring 16 km (10 mi); and Mound Springs 10 km (6 mi). The results indicated that surface deposition of Bg out of an airborne plume would be 1.0 x 10^{-11} kg/m^2 for all three locations, with diffusion to an even smaller concentration of 1.0 x 10^{-14} kg/m^2 over short distances from these locations (Espander, 2004 [Appendix J]). As indicated from the model run, the amount of Bg potentially entering these waters is exceedingly small. Bg would not have a significant effect on the White Sands pupfish or other biota in the area.

A similar HPAC model was generated for a simulated dimethyl methylphosphonate (DMMP) release from the Capital Peak HTD test beds using the same distances to the White Sands pupfish (WSP) habitat, with essentially the same findings.

However we believe that the modeling effort for Salt Creek is flawed, in that WSP occupied and “Essential” habitat occurs in the upper reaches of Salt Creek, approximately half the distance from the Capital Peak HTD test bed to Mound Springs, as compared with the 16.0 miles modeled.

Response 4-2. Additional modeling is not required since the entire area was covered in the initial model. However, a new expanded prediction has been added (Appendix J) showing the essential habit area. Adjustments were made to the HPAC model in which the distance to “Essential” pupfish habitat was reduced to 4.2 km (2.6 mi). The surface

deposition of Bg and DMMP were determined to be 0.1 $\mu g/m^2$ and 1.0 mg/m^2 respectively. Results indicate that the amounts of Bg and DMMP potentially entering "Essential" pupfish habitat are exceedingly small and would not have a significant effect on the White Sands pupfish or other biota in the area.

Comment 4-3. The Department is concerned about the potential for contamination of Salt Creek, the primary historic population of WSP by biological, chemical and radiological simulants' plume contamination of occupied habitat from aerosol deposition or by leaching through groundwater.

Page 4-40 of Volume I states, with regard to potential impacts on fish:

The effects of the proposed CBR test materials on fish and other aquatic organisms include toxic effects and the potential for bioaccumulation. Many chemical compounds, especially those with a hydrophobic component, partition easily into the lipids and lipid membranes of organisms and may bioaccumulate. If the compounds are not metabolized as fast as they are consumed, there can be significant magnification of potential toxicological effects up the food chain.

Many of the proposed chemical, biological and radiological weapons simulants are known to: 1) be toxic to fish, plants or insects which prey items for WSP (e.g., Bacillus thuringiensis (Bt); Methyl salicylate (MeS)); 2) have a high potential for bioaccumulation in fish and/or other aquatic organisms (e.g., Bis (2-ethylhexyl) hydrogen phosphate (Bis); Diethyl phthalate); 3) be a mutagen (an agent that increases the genetic mutation rate in organisms) or teratogenic (interferes with normal development of an embryo or fetus)(e.g., Cesium chloride (CsCl); Diethyl phthalate; Manganese dioxide (MnO_2); or 4) have a high potential to leach into groundwater, creating a pathway over time to occupied White Sands pupfish habitat (Dimethyl methylphosphonate; Dowanol DPM glycol ether (DPM); Propionic acid; Triethyl phosphate (TEP)).

None of these agents have been tested specifically to toxicity to the White Sands pupfish, many have not been tested for general fish toxicity using a proxy fish species, and the environmental fate of a significant number of these agents is unknown.

Response 4-3. The Department's concern is noted. DTRA proposes running predictions for any test utilizing simulants. Modifications or additional alternatives to test activities will be considered if predictions indicate that a test would be detrimental to the Salt Creek White Sands Pupfish population. It is further proposed that soil and water samples be taken after each test utilizing simulants.

As stated in section 4.2.1.4, proposed mitigations would include periodioc sampling of the stream waters containing pupfish to assure little or no impact to aquatic life. Any monitoring of pupfish habitat will be conducted in accordance with the White Sands Pupfish Cooperative Agreement and reporting will be conducted to the appropriate agencies.

Large quantities of ground water are not expected to exist in the Capitol Peak test area due to the shallow bedrock. In addition, other factors discussed in section 4.1.6.1, address the lack of viable pathways of simulants and other test materials to reach groundwater. However, to assess the effects and portability of test simulants in the affected environment, regular storm water analyses would be performed with reporting to appropriate agencies.

Comment 4-4. Therefore, the Department request that before any testing of collateral effects using simulant materials are authorized, additional HPAC modeling be conducted using corrected distances for occupied WSP habitat in Salt Creek, and that other alternative be considered if the modeling indicates that testing could be detrimental to the Salt Creek WSP population. We also suggest that new modeling information be provided in a supplement to the DPEIS before the Final EIS is issued, allowing the Department sufficient time for review and meaningful comments on the findings to be considered by DTRA.

Response 4-4. As stated in response 4-2 adjustments were made to the HPAC model in which the distance to “Essential” pupfish habitat was reduced from 16 miles to 4.2 miles. However, as previously stated deposition amounts are predicted to be exceedingly small and would not have a significant effect on the White Sands pupfish or other biota in the area. This new modeling information has been added to this document and was provided to NMGF during a site visit of the proposed test beds on 19 Sep 06.

In addition DTRA proposes running predictions for any test utilizing simulants. Modifications or additional alternatives to test activities will be considered if predictions indicate that a test would be detrimental to the Salt Creek White Sands Pupfish population. It is further proposed that soil and water samples be taken after each test utilizing simulants.

Comment 5 - Elizabeth and Tord Hillerstrom, Private Citizens

Comment 5-1. We appreciate that DTRA in this Draft made an attempt to answer at least some the issues we brought up in our letter of September 9, 2003, in particular our

concerns about possible effects of this testing under Alternative I on the seismic proclivities of the area. However, your researchers seemed to miss our point, i.e., that the potential for leakage of chemicals into the groundwater and seepage through rock layers into deep, far-reaching fissures in the surrounding areas can act as triggers for future earthquakes. The Draft makes a number of categorical statements, such as “Earthquakes in the Socorro area are unrelated to the fault zones with the WSMR.” Based upon references and information we submitted, together with the enclosed chart, we believe such a statement is entirely suppositional.

Response 5-1. There is no conceivable mechanism through which earthquake activity would be triggered through leakage of chemical simulants into ground water or rock layers. Chemical simulant tests will be surface and near-surface, with almost no potential for simulants to infiltrate to substantial depth. Monitoring wells established at PHETS have detected no simulants over several years of sampling.

Additionally, there is no evidence for Socorro-area earthquakes being causally linked to faults on WSMR. The high earthquake frequency near Socorro is directly attributable to an expanding underlying magma body. Comparatively, WSMR has much lower seismicity as would be expected with increasing distance from the magma body.

Comment 5-2. DTRA in this Draft attempts to obfuscate such a consequence by selecting a very narrow definition of earthquakes and stating that they are “caused by large earth movements”. (As are mudslides!) Yet in the Rocky Flats, CO earthquake incident, as well as several others, earthquakes are acknowledged to have occurred in correlation to seepage of chemical wastes into groundwater and eventually to magma, triggering severe quakes. (Stephen M. Younger, DTRA Director at Ft. Belvoir, VA, in a letter dated Jan. 16, 2004 to NM Sen. Jeff Bingaman, states “DTRA agrees that high pressure injection of wastewater into fractured basement rock could cause seismic activity.”). Since such seepage can follow fissures for great lengths and at varying depths, we question the certitude of the assumption that bedrock would shield the magma from chemical and water seepage after depth-testing of explosives at this site. The magma core underlying the cluster of 36 earthquakes, referred to as the Socorro Seismic Anomaly, has a minimum lateral extent of 3400km2 and extends for great distances through the Rio Grande Valley rift area and beyond and has exhibited slip-strike movements.

Response 5-2. Indeed, earthquakes are generated when large blocks of the earth move relative to each other. It is inappropriate to compare waste disposal through deep injection wells that has occurred at Rocky Flats with DTRA simulant testing. DTRA tests

will occur at shallow depths (no more than about 200 feet) and involve relatively small quantities of material that will largely be destroyed during the test. There is essentially no potential for chemical simulants to be conveyed deep into bedrock, affect faults and contribute to earthquake generation.

The Socorro magma body lies miles to the west of the DTRA test beds and, at a depth of approximately 19 km, has no possibility of contact with chemical simulants from DTRA tests. The concentration of earthquake activity near the Socorro magma body is well documented and is not related to DTRA or other testing on WSMR.

Comment 5-3. As to the assertion that "historically" there has been no earthquake activity in the vicinity of DTRA's depth testing, we refer you to the enclosed chart showing the historic seismic activity in the entire Socorro area extending past San Antonio, NM, specifically, as well as the entire surrounding area.

Response 5-3. Contrary to comment 5-3, the Draft PEIS states that there *have* been minor earthquakes documented historically on WSMR and evidence for prehistoric faulting. Apart from the Socorro area and its underlying magma body, the enclosed "chart" (map) shows the WSMR area to be seismically active at a level consistent for much of the state of New Mexico.

Comment 5-4. The magnitude of all this seismic activity is relatively unimportant, since historically, the amount of explosive depth testing you plan to use (i.e., 500-ton TNT, etc.) under Alternative I has never before been attempted, to our knowledge, in the areas you plan to use for depth testing. It would therefore appear that – just as your Draft frequently makes use of the term "historic" in this context (and as the term "not expected" is applied when referring to the consequences of chemical toxicity), this statement has little background in fact and is the result of assumptions.

Response 5-4. Large-scale explosive tests on WSMR DTRA test beds, primarily using ammonium nitrate/fuel oil mixtures, have been conducted intermittently for decades, ranging from hundreds up to thousands of tons TNT equivalency. These tests have been at the surface or near-surface and not, as implied in comment 5-4, "depth tests", nor are there plans for deep static explosive tests under this PEIS. There is no evidence that these large-scale explosive tests have induced or precipitated earthquakes. Had this occurred, seismologists or other earth scientists, especially at New Mexico Institute of Mining and Technology (Socorro), would have readily seen a possible connection and reported this in research papers; this has never transpired.

Comment 5-5. Further, since tidal moon action is frequently a precursor of seismic activity, will a potential confluence of such tidal action and chemical seepage into the existing underlying magma, be a dual trigger? We suggest that you step away from your narrow earthquake definition to include "potential causal events."

Response 5-5. The effect of the moon's gravity on earthquake occurrence has not been strongly supported by most earth scientists and is inconclusive at best. Analysis of the dubious "causes" mentioned in the comment exceeds the scope necessary for completion of this PEIS.

Comment 5-6. Will DTRA or the United States government assume fiscal liability and moral responsibility toward the citizens of the outlying areas? As previously noted in our attached 9/9/03 letter, this has not been the case in recent events of toxic chemical drift and explosive property destruction in this area by your agency. Your PEIS Draft did not address this complaint at all. We therefore re-submit our letter of 9/09/03 for re-consideration, along with this one.

Response 5-6. There are claims procedures available for individuals who believe that Government actions have caused them damage or injury. The purpose of this Environmental Impact Statement is to insure that potentially impacted communities are informed in advance of possible environmental impacts from Government activities, in this case specifically the proposed actions of the Defense Threat Reduction Agency at WSMR. If you, or any of your neighbors, feel that Government activities at WSMR have caused you damage or injury, you may file a claim with the closest claims office, which would be White Sands Missile Range, NM.

Comment 5-7. DTRA appears anxious to bury all issues with pat evasions in this as well as in other areas. With the health, welfare and safety of US citizens of the Socorro/San Antonio area at stake, we are disappointed in your approach, and hope a more serious investigation will come forward. We do not accept your conclusion that the third alternative of "moving WSMR elsewhere" had to be dropped because of "lack of space" elsewhere. We are fully aware that the US government possesses virtually uncounted acres of land far from human populations. Perhaps the EIS should address the possibility of protecting the lives of US citizens by embracing that dismissed third alternative, and moving this testing to an area uninhabited by human beings and vulnerable creatures.

Response 5-7. The remote area where DTRA test activities take place was chosen because it was and is sparsely inhabited by human beings. To date no vulnerable Federal

or State listed species occur on or near DTRA test beds making this area an ideal area for DTRA test activities.

Comment 5-8. The City of Albuquerque is now facing the onslaught of the toxic pollution of its water supply due to long-term seepage from Sandia National Laboratories' "Mixed-Waste Landfill" (1959 to 1988). Sandia Labs is now being sued and we expect that, after these proposed tests have faded into infamy, DTRA will be held responsible for the harm it is now doing and attempting to do locally to our people and to New Mexico's environment.

Response 5-8. Comment noted.

Comment 6 - Steve Harrington, Private Ctizen

Comment 6-1. As a person with a background in science and technology, I strongly oppose the proposed increase in testing by the Defense Threat Reduction Agency (DTRA) at White Sands Missile Range (WSMR). I took the time to read the entire 600+ pages of the draft Programmatic Environmental Impact Statement (PEIS) cover to cover, including both the main body and the appendices. Despite a clear attempt by the report's authors and/or editors to make the case that expanded testing is both justified and safe, what I found in the report raises many serious questions. Because the report is quite lengthy, it is a somewhat overwhelming job to critique it in its entirety. I will hit some of the more troubling spots, but the problems noted herein are by no means a comprehensive list of the shortcomings of the report.

The PEIS report, while presented in a very scientific manner, is actually full of undocumented or partially documented suppositions. In fact, I did a word and phrase count using the Adobe Acrobat Reader software, and found the phrase "is not expected" (e.g. some substance or action "is not expected" to harm the environment) used 93 times; similarly, the phrase "is expected" is used 111 times in the report, the phrase "is not likely" is used 21 times, and the word "unlikely" also makes a strong showing with 46 occurrences. Many of these phrases are used with limited supporting evidence, supporting evidence cited out of context, or evidence that is only marginally related to the action being proposed.

Response 6-1. The comment is noted, but general comments without specific examples such as the one regarding "limited supporting evidence" cannot be answered effectively. The NEPA process is designed to analyze both known effects and potential effects; therefore, qualifying terms must be used in some instances to accurately state the

potential for effects. Doing a review by performing a word and phrase count can lead to misleading interpretations of context. For instance, the first example of the phrase "is not expected" comes in a sentence on page 4-21 where it states "The Lifetime Health Advisory Level (HAL) for DMMP established by the U.S. Environmental Protection Agency, which is the estimate of the concentration of a chemical in drinking water that is not expected [emphasis added] to cause any adverse non-cancer effects for a lifetime of exposure, is 100 :g/L (U.S. EPA, 2000)." In this instance DTRA has made no claim to not expecting consequences from its actions, as implied by the comment.

Comment 6-2. For example, while the report claims that the environmental impacts (of the proposed testing option) on avian and mammalian wildlife would be negligible, the same report admits that "the effects of exposure of the proposed chemicals on avian wildlife is unknown" (page 4-39 of the report), and "the effect of exposure of the proposed test materials on mammalian wildlife is largely unknown" (page 4-37). On page 4-35, the report notes that "the effects of chemical, biological, and radiological simulants and other test materials on native faunal species are largely unknown."

As another example, the report agues that the bio-simulant Bg (Bacillus Subtilus) is "generally not pathogenic to humans", but goes on to note that "in rare cases Bg has been associated with livestock abortion and crop disease" (page 4-35). Do we really need to be testing with items known to be associated with livestock abortion and crop disease? I would suggest not. The report also notes that repeated use of Bg may affect beetles and moths, affect the reproductive ability of plants, and affect animals which are insectivores (i.e. that feed on beetles, moths, and other affected insects).

Response 6-2. Bg is not considered by the American Society for Microbiology to be a plant pathogen. Although the presence of Bg has been detected in aborted fetuses of cattle, it has never been identified as the causal agent (USEPA, 1997). This statement has been integrated into sections 4.2.1.3 and F-5 of the current draft. Although laboratory testing of Bg has been shown to have detrimental effects to the root systems of potato tubers, only one natural occurrence of Bg as the causative agent is reported (disease of Norway maples in the Urals). Norway maples are neither a native species of WSMR nor a crop of the area.

Comment 6-3. Yet another example of the report attempting to downplay risks is found on page 4-28 of the report, where the authors note "the effects of DMMP on plants is not known" but conclude (apparently on faith) that it "is not expected to significantly affect flora." If the effects of DMMP on plants are not known, I really do not care what the DTRA "expects." Science is not based on expectations or feelings, but on hard empirical

data. The report itself states that the effects on plants is not known. This appears to be a clear example of faith-based science, which is in fact not science, but advocacy or lobbying.

Response 6-3. The complete sentence on page 4-28 states, “Although the effects of DMMP on plants is not known, the amount of DMMP deposited on the surface is very small and is not expected to significantly affect flora in the test area.” The conclusion that DMMP is not expected to significantly affect flora is based on the amount of DMMP that would be deposited on the ground surface. These quantities were derived from predictive modeling and results were summarized on page 4-28, “The analytic results show a peak surface deposition of one hundred milligrams per square meter for a four hundred fifty-four kilograms release (Espander, 2005 {Appendix I}).” Proposed mitigation includes annual sampling of Land Codition Trend Analysis (LCTA) plots inside the PHETS boundaries to assess the impacts of DTRA activities on flora (see page 4-51).

Comment 6-4. The DTRA suggests that a non-infectious influenza-A virus be used as a bio-simulant, simulating more dangerous biological agents. The report correctly notes that a dead virus strain would be non-infectious. Nowhere in the report, however, does it address the question of what happens if a live virus is mistakenly used. In fact, the entire report reads as if mistakes and errors are not possible, thus never asking questions such as “what happens if something goes wrong or our predictions aren’t accurate” or “what happens if the science is wrong on this”? We all know of many cases where a substance was deemed safe for years, only for the scientific community to later realize otherwise. We need look no further than the history of nuclear weapons testing, where our government – possibly as an honest mistake based on the science available at the time – exposed many in our country to dangerous levels of radiation. Similarly, there are numerous cases of species being introduced, for benign or beneficial purposes, into an area in which they were not native only to later have the introduced species take over and wreak havoc on the environment. Introducing live bacteria, (hopefully) dead viruses, and so forth, is really banking on perfect science and perfect test implementations, with mistakes or human errors not allowed for in the report or the analysis. This seems dangerously short sighted.

Response 6-4. Only influenza A virus, killed and non-infectious, is proposed for use in the biological simulant testing. Production and supply of this simulant will be conducted by a manufacturer with proper quality assurance and quality control measures in place.

Comment 6-5. Among the more puzzling contradictions, of which there are many, in the DTRA proposal is DTRA's position on computer modeling as an alternative to real-world testing. In several places, the DTRA argues that while computer models are useful, they are not sufficient and cannot be used as replacements for real-world tests (page S-5, page 2-24, etc.). However, having made the argument against computer modeling, the report then goes on in self-contradictory fashion by using computer models (for example, models of plumes of chemicals and their dispersal into the atmosphere, computer models of water runoff, and so forth) as support for the idea that materials will not adversely affect the environment (e.g. page 4-67). Page 4-58 of the report recommends creating predictive models (i.e. computer models) to "ensure hazardous quantities of test materials do not exit the range." It seems the DTRA wants to use computer models as "hard" evidence when it's convenient to them, while at the same time arguing that they cannot be trusted as replacements for actual test. Either computer models are sufficient or they are not, but they obviously cannot be both at the same time.

Response 6-5. Computer modeling and simulation, in regard to collateral effects testing, is an important tool for predicting the fate and transport of chemical and biological weapons materials. The *sole* use of computer modeling and simulation for DTRA activities was an alternative considered; however, it was not carried forward. Real data acquired in field-testing scenarios is necessary to refine the models and validate model predictions. Computer modeling and simulation without actual test data is insufficient.

Comment 6-6. The DTRA's proposed expansion of testing at White Sands Missile Range would involve the dispersal of literally hundreds of chemical or biological agents into the environment and atmosphere. While the report attempts to list all of these agents with any known dangers noted, the report itself admits that "in-depth information is not available for each chemical: and furthermore says "concentrations at which other simulants produce phytotoxicity are not well studied" (page 4-29). As the report notes, if the DTRA's proposed option is granted, it is expected that simulants in the air will escape White Sands Missile Range boundaries – an admission that the DTRA cannot strictly constrain the chemical and biological agents' dispersal.

It is also very troubling that for each chemical, the DTRA's proposed option would allow up to 16 tests with each test dispersing up to 4,000 pounds of the chemical, for a total of 64,000 pounds per test material. With hundreds of test materials proposed for use, this is literally hundreds of thousands (if not millions) of pounds of chemicals that are proposed for release in the missile range, with much of the science incomplete.

Response 6-6. To ensure CBR and HE quantities of test materials do not exit the range the development of computer models will be used prior to collateral effects tests (Vol I, 4-58). A "no go" criteria will be developed on a case by case for each test. All test amounts will be modified to fit test requirements and ensure compliance with state and federal regulations. Any additional documentation will be handled accordingly.

Comment 6-7. While the environmental problems are my primary concern with the proposed option (of expanded DTRA testing at WSMR) – and while I could go on for many pages citing additional problems or contradictions in the report – I would like to point out one problem that is not environmental in nature, but which I believe illustrates the lengths to which the report's authors will go to bend the truth to meet their desired goals. On pages 2-19 to 2-22 of the PEIS, the report notes that an agreement between WSMR and New Mexico's State Historic Preservation Office (SHPO) prohibits building any new permanent structures on the area comprising the Trinity National Historic Landmark. Yet, the proposal by the DTRA suggests building permanent structures in violation of this agreement: "DTRA proposes to upgrade the PHETS Administrative Park by replacing the trailers/temporary structures with energy efficient pre-engineered buildings placed on concrete slabs. These pre-engineered buildings and concrete slabs are temporary structures that would be dismantled and removed when no longer needed" (page 2-22). This is probably the most egregious example of Orwellian government double-speak in the report.

Using DTRA's absurd definition, no building of any kind is a permanent structure because any building can be torn down. This is clearly an intentional misreading of the intent of the agreement between WSMR and New Mexico's SHPO, with DTRA proposing a willful violation of the agreement with both malice and forethought. Clearly, any reasonable person would admit that a structure with a concrete slab is, in fact, a permanent building. No amount of government double-speak can change that fact. That DTRA would even attempt to make a preposterous claim like this illustrates in a clear and concise way the lengths to which they will go to lobby for the expanded testing, i.e. the "proposed option". It seems that facts, environmental concerns, and agreements are of little import to those who want to increase DTRA testing and that they believe that a little "spin" can make anything seem reasonable to the public. Suffice it to say, nothing could be further from the truth; the public is simply not that gullible.

Response 6-7. SHPO has been and will be consulted with construction plans by WSMR archaeologists, prior to placement of any facilities within the National Historic Landmark. All new structures placed within the National Historic Landmark will be temporary and all temporary structures will be removed after completion of the action.

Comment 6-8. As I said, I could go on for many, many, many pages citing additional defects in the PEIS draft for DTRA's proposed testing at WSMR. However, the intent of my letter is not to make an exhaustive list of the PEIS draft's shortcomings. Rather, I want to publicly document the bias and agenda of the PEIS report's authors and/or editors. The report has a clear agenda. This agenda may be wrapped in a package that appears to be science-based, but the report's façade of scientific rigor quickly unravels with even the slightest critical analysis. In summary, I urge you in the strongest terms possible to choose the "no action" option and to reject the flawed environmental impact analysis of the DTRA's "proposed" option for expanded testing at WSMR.

Response 6-8. Comment noted.

Comment 7 - Kathy Albrecht, Private Citizen

Comment 7-1. I intend for these comments to be included in their entirety in the Final DTRA White Sands PEIS. They are submitted on March 28, 2006, the date "comments will be accepted until." I protest that my Scoping comments and those of others were not printed in the Draft PEIS and I believe the reason is found on page s-5: "The elimination of DoD development and testing of weapons to reduce the threat of WMD was suggested at a public information meeting … This alternative is a national policy issue beyond the scope of the PEIS [&] Therefore … was excluded from further consideration."

Response 7-1. All comments have been included in their entirety in this document.

Comment 7-2. An EIS process is driven by the NATIONAL Environmental POLICY Act. How disturbing that Americans' concerns that the premier testing ground of the U.S. arsenal threatens not only the environs of WSMR, but additionally the nation's and global environmental health by exacerbating warfaring tensions worldwide, be deemed "beyond the scope" of making a decision to expand weapons testing. I live scarcely 13 miles from the Large Blast/Thermal Simulator; mine and other disarmament advocates' comments will NOT be "excluded from further consideration," lest you invite litigation.

First, I take issue with the bias reflected throughout the DPEIS, that the No Action alternative would "reduce the Department of Defense capability to control and eliminate weapons of mass destruction" and that DTRA assists "in safeguarding the United States and its allies from weapons of mass destruction" or counters "proliferation of WMD." Few thoughtful, informed world citizens today believe that over-armed America has "a need to improve weapon systems designed to defeat enemy military assets" (S-2). And isn't The Pot (with our ready nuclear arsenal) calling The Kettle 'black' to warn that such

enemies might "house WMD and pose a significant threat to international stability and peaceful coexistence"?

We are the state which has refused to honor our treaties and the world's chief tribunal and accomplish nuclear disarmament, thus goading reluctant states into proliferation. We possess, many times over, the most massive conventional firepower on earth and we now blast away annually at civilians around the globe, often from 35,000 feet, whenever we're so moved. Don't try to tell the public that expanding northwest White Sands explosive testing activities will engender planetary peace nor make Americans more secure. All these proposed activities will do is soak up a hefty clump of obscene $500 billion to $1 trillion annual Pentagon budgets for a decade, line the pockets of arms developers' stockholders and further drive the forces who deny the U.S. vicious world domination to more and more desperate acts of resistance.

Both DTRA's WSMR activities and those desperate acts, my friends, comprise horrendous potential environmental threats to this nation. And I, as a citizen and test-site neighbor, have the obligation and the privilege to point that fact out during this EIS preparation! Don't you dare exclude Disarmament (let alone No Action) "from further consideration" - - ever! It is undoubtedly our only hope. I challenge each of you well-meaning preparers and decision-makers to recommit your life's work to dismantling this military beast. Or at least to stop feeding it.

Response 7-2. The scope of this document covers DTRA actions on White Sands Missile Range. Though these comments are noteworthy, they are within the National Military Strategy and beyond the scope of this document.

Comment 7-3. Meanwhile, "lethality and defeat testing", "advanced weapons lethality," "high explosives target lethality" ought not to be pursued where 17 rare and threatened plant species native to New Mexico and to White Sands are thus endangered. (C1-5) The two Bacillus simulants ought not to be excused as common soil bacteria and released to threaten precious moths who serve that ecosystem by pollinating flora. (…"simulants may cause plant mortality, impair plant growth, or reduce plant reproductive success" S-9) Numerous greenhouse gases resulting from WSMR explosions ought not to be released into a climatological situation already on-the-ropes. 100 chemical compounds released in DTRA testing are deemed Hazardous. And how grimly ironic that a full 24 mammalian, avian, reptilian, and aquatic species which are either Endangered or Threatened attempt to take refuge amidst the toxins generated by White Sands Missile Range! Stop this madness.

Response 7-3. Only four plant species occurring on WSMR have either Federal or State threatened or endangered plant species status which are afforded legal protection. These plant species are not located near any DTRA test beds and are unlikely to be affected. Only eight faunal species having either Federal or State status as threatened or endangered are known to occur on WSMR. Four of these faunal species are avian and are transitory usually passing through WSMR and have rarely been sighted.

Mitigation was added to Section 4.2.1.3 to minimize potential impacts to yucca moths and yucca pollination. Tests requiring the use of *Bacillus thuringiensis* (Bt) will not take place during the month of June, the peak flowering time of soaptree yucca. By not conducting Bt tests during the moth of June, moth eggs being laided inside the yucca will not become contaminated, and the resulting larva will thereby be protected during the most vunerable stage in the life cycle of the yucca moth.

Comment 8 – Dave Wunker, Private Citizen

Comment 8-1. I oppose any expanded testing of biological or chemical simulants by the DTRA at White Sands Missile Range. I am amazed at the amounts of such materials that are being considered for the release into the atmosphere. Many of these are toxic to plants and animals at some level. The effects of others are unknown.

Why do we as a society continue to play Russian roulette with the chemicals when we are plagued with various cancers, most of which probably have an environmental origin? I have had one sister die of cancer and another requiring a mastectomy because of breast cancer. Now we are also going to play around with bacterial agents, when various bacterials infections we thought we had under control are on the rise (like tuberculosis), and our immune systems are becoming compromised.

Efforts need to be concentrated on preventing and addressing conflict before it reaches the stage when someone or some country is willing to use bacteriological or chemical weapons.

Testing of real conflict situations should be confined to computer modeling or if field testing seems absolutely necessary, then only materials known to be non-toxic to all living things should be used.

Reponse 8-1. Comments noted.

Comment 9 – Julie A. Walter, Private Citizen

Comment 9-1. My comments are in response to the oral comments made by the first woman who commented during the oral comment session of your public review in Socorro. First of all, I want to say that I think your program is an excellent way to help protect Americans and the American public from future disasters like that of September 11. A comment was made about several corporations (Ratheon, Lockheed Martin, GE, etc.) bringing in huge profits to develop weapons of mass destruction for the United States Military. This is a blatant mis-statement, while many of these companies do fulfill contracts for the U.S. military, they do not actually develop the weapons of mass destruction that I understand are to be simulated at this test facility.

Another comment that I would like to respond to is the comment that was made about having to retrain the youth of America to work with these weapons every time a new weapon/technology is developed. It is my understanding that this test facility is using materials that simulate that impact of these weapons of mass destruction, not the actual thing. Also this testing is not to be done by the youth of America, but by trained professionals. Finally, I don't really see this being a problem as many, if not all nuclear warheads are not fired by people who stand right next to them like a cannon, but are fired remotely, and can be fired from clear across the world, which does not pose any threat to our youth, as was expressed in the oral comment section.

In conclusion, I feel that DTRA's proposed program is an excellent way for the U.S. military and government to find the most efficient way to respond to an attack on a large scale should such an attack occur. One of the major complaints of the government today was the lack of early/quick response to both Hurricanes Katrina and Rita. I think that this testing program is an excellent response of the government to be able to have a more timely response to such things that would endanger much more than one region of the country. White Sands Missile Range and DTRA's testing plan is the best way for the United States to prepare itself for any future attack on our people and our way of life and allows the government to develop the most effective way to deal with any such attack.

Reponse 9-1. Comments noted.

Comment 10 - Kendrick Walter, Private Citizen

Comment 10-1. I would like to comment of some of the comments that were made by the first lady to speak during the oral session at the Macey Center in Socorro, New Mexico. She made a comment on how the youth of America couldn't keep up with the

chemical and biological strategies that are currently being used. As a student, I have noticed that the future of warfare will be more than likely be some sort of chemical or biological weapons. I feel that some of comments are not accurate, I feel that the DTRA has proposed a new plan that will ultimately help American citizens if another terrorist attack were to take place.

One of the biggest complaints of the Katrina Hurricane disaster was how quickly Government agencies responded to those in need. I feel that DTRA is trying to improve how we respond to an unexpected attack. Even though Katrina wasn't a terrorist attack we still learn from it. If we know how biological and chemical warheads work we can quickly respond to the attack, which may save millions of lives. To conclude, I feel that the DTRA has proposed an excellent plan to open a new testing site.

Response 10-1. Comments noted.

Comment 11 - Kathryn Albrecht, Private Citizen (Oral comments from Soccorro public hearing March 2, 2006)

Comment 11-1. My name is Kathryn Albrecht. I'm from San Antonio, New Mexico. I work here at Tech in Socorro. I very much appreciate the fact that I am able to comment about the NEPA process, and I'm grateful that the north end of the missile range decided that they need to go with a PEIS.

I right away want to surface a question I have about the role in these particular test beds and facilities are utilized for the stated purpose, or maybe not. I know there have been areas out there that were prepared for certain tests, and those tests never occurred and then declared from this draft PEIS that those areas were then adapted and used for other testing initiatives such as those you were going to do in Socorro.

Response 11-1. Previous Environmental Assessments were prepared to analyze the effects of past DTRA activities including construction of test beds and testing. To allow for greater flexibility and to analyze cumulative impacts, existing DTRA test beds were included in this Programmatic Environmental Impact Statement.

Comment 11-2. What happens when these facilities that are being covered in this PEIS, what happens when it's time for those areas to be either redeveloped for more projects, different projects? What sort of mechanism is in place to update the PEIS to cover - - is it amended? Is it revised? Do we go back to the drawing board? What is that mechanism? I would like to hear that addressed.

Response 11-2. Supplemental NEPA documentation would be prepared to consider the effects of redevelopment of DTRA facilities or conducting test projects that are outside the scope of this PEIS.

Comment 11-3. I congratulate the people that covered the environmental issues that were scoped, everything that they could think of to do for a responsible document. I think I will address any details that I am learning from studying the document in writing within the comment period.

Resonse 11-3. Thank you, comment noted.

Comment 11-4. Tonight what I would like to address is the overall mission of the Defense Threat Reduction Agency, the overall mission of the pentagon and the government of the country in continuing to modernize our weapon capabilities, our war fighting capabilities and reflect on how it effects society.

When I look at what is going on, the incredible disablization of the national relations at this point in time and a war with no end in sight that has caused numerous civilian casualties and military casualties, I see one analysis that explains it all to me, because otherwise it sounds insane. And that is that there are private contractors, large corporations that make incredible profits with the contracts for the US military building weapons, weapons of mass destruction.

I mean if you dropped some of this on populated areas, there would be a lot of causalities, and you'd see the effects afterwards for many years to come. And we don't want that. I don't know where you want to draw the line with weapons of destruction, but we make a lot of them. I believe that the stockholders of the weapons contractors in this country and the vast profits that they make is the engine driving this entire thing, and I believe that White Sands Missile Range plays a key role in allowing this to continue and to go on, this incredible expenditure and all of this toxification of the environment, not doing anything to reduce the threat to the planet, the threat to peace on earth, or certainly the threat to our environmental struggles that we have.

You can describe the intents of the various test beds, the weapons that they intend to test, but we all know the probably in 18 months or so we're onto a whole new set of weapons. Our youth are not properly trained to handle these weapons the way maybe gunners on the battleship in the forties were able to, you know, work for several years with one set of ordinances and its delivery capabilities and get really good at it. We just now change out the stuff so rapidly. The universities suck up the money to develop this stuff and test it

out at White Sands, wherever else you're testing and put it out in the field. I would really like to see some true threat reduction.

Response 11-4. Comment noted.

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12.0 GLOSSARY

A

abundance– the total number of organisms in a biological community.

acetylcholinesterase- an enzyme that occurs especially in some nerve endings and in the blood and promotes the hydrolysis of acetylcholine.

adrenal medulla- the inner portion of the adrenal gland. The adrenal medulla secretes the stress hormones noradrenaline and adrenaline.

Aerial Cable Range (ACR)- located in the northern portion of WSMR and consists of a 4,560-meter (15,000-ft) cable with a mobile target-carrying trolley suspended between two mountains.

aerobic- occurring only in the presence of oxygen.

aesthetics- the study or theory of beauty and of the psychological responses to it.

agranulocytosis- an acute blood disorder (often caused by radiation or drug therapy) characterized by severe reduction in granulocytes.

airblast- air vibrations produced by an explosive charge.

albic-a bleached, light colored horizon from which the clay and free iron oxides have been removed.

algae blooms- massive growths of microscopic and macroscopic plant life, algae which develop in water bodies.

alkali flat- a playa, or dried-out desert lake, especially one containing high concentrations of precipitated dry, glistening salts.

Allotropic- the existence of a substance and especially an element in two or more different forms (as of crystals) usually in the same phase

alluvial fan- the alluvial deposit of a stream where it issues from a gorge upon a plain or of a tributary stream and its junction with the main stream.

alluvial flat- a flat bottomed desert floor formed by a dried-out desert lake.

amorphous- having no definite form.

anesthesia- loss of sensation with or without loss of consciousness.

anhydrous- without water.

anthropogenic- produced by human activities.

antiseptic- preventing the growth of microorganisms.

antioxidant- a substance that inhibits oxidation or reactions changed by oxygen or peroxides.

anti-terrorism tests- tests designed to examine the survivability of personnel and property against a terrorist attack, mainly using explosives.

aqueous- made from or related to water

aquifer-an underground bed or layer of earth, gravel, or porous stone that yields water.

arid- a term used for an extremely dry climate.

arrhythmia- an alteration in rhythm of the heartbeat.

arroyo- a small, relatively deep, flat-floored channel or gully of an ephemeral or intermittent stream. It is usually dry and has steep banks of unconsolidated material.

artifact- any object made, modified, or used by people.

aspect- the relative direction or compass orientation of a land slope.

asphyxiant- s a substance that can cause unconsciosness or death by suffocation.

audible- that is heard or that can be heard.

B

background noise– a more or less steady level of noise above which the effect being measured by an apparatus is detected.

bacteriophage– a virus that infects bacteria.

bacterium- any of a group (as kingdom Procaryotae syn. Monera) of prokaryotic unicellular round, spiral, or rod-shaped single-celled microorganisms that are often aggregated into colonies or motile by means of flagella, that live in soil, water, organic matter, or the bodies of plants and animals, and that are autotrophic, saprophytic, or parasitic in nutrition and important because of their biochemical effects and pathogenicity.

basalt flow- solidified lava composed of a dense dark gray fine-grained volcanic rock.

bedrock- the solid rock that underlies loose material, such as soil, sand, clay, or gravel.

berm- a mound or wall of earth.

Best Management Practices (BMPs)- schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce wind or water erosion.

bilateral- having two sides.

bioaccumulation- a progressive increase of the bodily content of a compound.

bioconcentration- the accumulation of a chemical in tissues of a fish or other organism to levels greater than that in the surrounding medium (environment).

bioconcentration factor- the ratio of chemical concentration in the organism to that in surrounding water.

biological oxygen demand (BOD)- a measure of the amount of oxygen needed by aquatic organisms to break down solids and other degraded organic matter present in waste water or water.

biological simulant- a biological substance, or microorganism that shares at least one physical or biological characteristic of a biological agent, has been shown to be non-pathogentic, and can be used for biological defense testing to replace the agent under study.

biomagnification- an increase in concentration of a pollutant from one link in a food chain to another.

biota- the combined flora and fauna of a region.

biotransformation- the transformation of chemical compounds within a living system.

blasthole- is a cylindrical vehicle designed and strategically situated to hold and contain an explosive charge so that it can be detonated in the most efficient manner.

brackish- used to describe undrinkable water; salty water.

brine- strong saline solution.

C

caliche- a hard, crusty, whitish rock that accumulates near the surface as calcium carbonate and other minerals fill pore spaces in gravel.

call-up area- extensions or areas of land adjacent or nearby WSMR that the Department of the Army and residents/land land owners have agreed can be used as extensions of WSMR during testing. E.g. The DoA has agreements with individuals using the North Extension call-up area to evacuate the premises for testing purposes upon request.

carbon-14 dating- the determination of the approximate age of an ancient object, such as an archaeological specimen, by measuring the amount of carbon 14 it contains.

carbon monoxide- a very toxic, colorless, odorless gas (CO) that burns to carbon dioxide and is formed as a product of the incomplete combustion of carbon.

carcinogen- a cancer-causing substance or agent.

chemical simulant- a chemical substance that shares at least one characteristic of a chemical agent but with a reduced physiological effect.

chemical stabilization- materials made of vinyl, asphalt, or rubber are sprayed onto the surface of the soil to hold the soil in place and protect against water and wind erosion.

chert- hard, dense sedimentary rock, composed of interlocking quartz crystals.

chlorofluorocarbons (CFCs)- are nontoxic, nonflammable chemicals containing atoms of carbon, chlorine, and fluorine.

cholinesterase- an enzyme that hydrolyzes choline esters and that is found especially in blood plasma.

chronic- lasting for a long period of time or marked by frequent recurrence, as certain diseases.

colloidal clay- extremely fine, microscopic particles of rock.

conjunctivitis- pinkeye.

collateral effects testing- testing designed to measure the potential effects to non-military personnel or property after the defeat of a simulated weapon of mass destruction target.

colonizing species- first species to establish after a disturbance.

combustible liquids– liquids which have flash points greater than 60.5°C (141°F) and below 93°C (200°F).

compliance- the practice of conforming to laws and regulations.

consortium- an agreement, combination, or group formed to undertake an enterprise beyond the resources of any one member.

contamination- to make unfit for use by the introduction of unwholesome or undesirable elements.

convectional thunderstorms- these are intense local storms associated with tall, dense clouds with strong updrafts and downdrafts.

corneal opacification- other disorders of the cornea that cause decreased visual function.

corrosivity- capable of corroding metal storage tanks or containers that may result in release of the material, or may injure persons who come in contact with it.

cutaneous- pertaining to the skin.

countermeasures- the form of military science that employs devices and/or

techniques to impair the operational effectiveness of enemy activity.

critical habitat- Critical habitat is a term defined and used in the Endangered Species Act. It is a specific geographic area(s) that is essential for the conservation of a threatened or endangered species and that may require special management and protection.

cultivation- planting, growing, and harvesting crops or plants, or preparing land for this purpose.

cultural resources- sites, structures, landscapes, and other objects of importance which have cultural value for a group of people for scientific, traditional, or religious reasons.

cumulative impact- the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

cyanosis- a bluish or purplish discoloration due to lack of oxygenated blood.

D

decomposition- the natural precess the of laying down a deposit of something.

degradation product- those chemicals resulting from partial decomposition or chemical breakdown of substances.

dehydration- excessive loss of water from the body or from an organ or body part, as from illness or fluid deprivation.

deliquescent- becoming liquid by absorbing moisture from the air.

desalinization- a process of removing salts from a water source to make it available for human consumption and agriculture.

diffusion– the movement of molecules from an area of high concentration to an area of lower concentration.

dimerization- the chemical union of two molecules.

dinitrotoluene- is usually formed by mixing toluene with nitric acid in the presence of concentrated sulfuric acid.

dispersion- the state of being dispersed, a random distribution or scattering from a fixed or constant source.

distillate- something concentrated

divalent compound- having a valence of two

diversion berms-a earth or gravel berm used to protect work areas from upslope runoff and divert sediment-laden water to appropriate traps or stable outlets.

diversity– a measure, either qualitative or quantitative, of the variety of species contained within a habitat.

dosimetry- The accurate measurement of doses, especially of radiation.

draize test- application of any material or substance to the eye of an animal.

drone - an unmanned airplane, helicopter, or other aerial vehicle guided by remote control.

dry composition- the distance in the line of advance of a wave from any one point to the next point of corresponding phase.

dysprosium- an element that forms highly magnetic compounds.

E

ecosystem- a complex, self-sustaining natural system that includes living and non-living components of the environment and the circulation of matter and energy between organisms and their environment.

ecotoxicity- is the study of how chemicals affect the environment and the organisms living in it.

edema- watery swelling of plant organs

electrodialysis- the rapid removal of undesired ions from solution by the application of a direct current to electrodes inserted into a dialysis system.

emissions- substances discharged into the air (e.g. a smokestack, automobile gasoline engine).

Endangered Species Act- an act of the U.S. Congress of 1972 that requires Federal agencies to ensure that their actions do not jeopardize the existence of endangered or threatened species.

endemic- native to or confined to a certain region.

endocarditis-inflammation of the lining of the heart and its valves

endocrine system- a collection of glands that produce hormones that regulate your body's growth, metabolism, and sexual development and function.

energetics testing- testing done to enhance the explosive power of weapons.

ephemeral- lasting for a very short time.

erosion- the set of all processes by which soil and rock are loosened and moved downhill or downwind.

erythrocyte- red blood cell.

escarpment- a steep slope or long cliff that results from erosion or faulting and separates two relatively level areas of differing elevations.

etiology- the cause or origin of disease.

evaporation rates- the rate at which liquid water is transformed into a gaseous state.

evapotranspiration- a combination of evaporation from open bodies of water, evaporation from soil surfaces, and transpiration from the soil by plants.

exacerbate-to make more severe.

exponentially- describes growth that proceeds in a manner characterized by periodic doublings.

F

fault- a surface or zone of rock fracture, where there has been displacement of land from a few centimeters to a few kilometers in scale.

ferro-magnesium- minerals containing iron and magnesium

fibrosis- a condition marked by increase of interstitial fibrous tissue

flammable- Easily ignited and capable of burning rapidly

food chain- the step-by-step passage of matter and energy (food) through an ecosystem, beginning with vegetation and ending with carnivores.

food web- a network of interlocking food chains.

forb- a broad leafed herbaceous plant as distinguished from grasses, sages, shrubs, and trees.

fragmentation- process to break up into fragments

frostbite- frozen body tissue caused by prolonged cold exposure

functional group- an atom or group of atoms, such as a carboxyl group, that replaces hydrogen in an organic compound and that defines the structure of a family of compounds and determines the properties of the family.

G

gabions- rock filled wire cages used for erosion control.

gastrointestinal- affecting, or including both stomach and intestine

gastropods– any of a large class of mollusks such as snails and slugs.

geotextiles- porous fabrics manufactured by weaving or bonding fibers made from synthetic materials and used for erosion control.

glucose- A monosaccharide sugar, $C_6H_{12}O_6$, occurring widely in most plant

and animal tissue. It is the principal circulating sugar in the blood and the major energy source of the body.

glutathione- a polypeptide of glycine, cystine, and glutamic acid that occurs widely in plant and animal tissues and is important in biological oxidation-reduction reactions.

glycoprotein- Any of a group of conjugated proteins that contain a carbohydrate as the nonprotein component.

ground zero- the target of a projectile, such as a missile or bomb; the site directly below, directly above, or at the point of detonation of a weapon.

gypsic- a soil horizon enriched with calcium sulphate, more than 15 cm thick.

gypsum sand- sand-size gypsum (calcium sulphate with water) crystals that form dunes at the edge of Lake Lucero in the Tularosa Basin.

H

habitat– the environment or place where an animal or plant normally lives and grows.

habituate– to make used to a particular stimulus.

half-life- the time required for half the amount of a substance (as a drug or radioactive tracer) in or introduced into a living system or ecosystem to be eliminated or disintegrated by natural processes

heat exhaustion- a condition caused by exposure to heat, resulting in the depletion of body fluids and causing weakness, dizziness, nausea, and often collapse.

hematopoietic system- The bodily system of organs and tissues, primarily the bone marrow, spleen, tonsils, and lymph nodes, involved in the production of blood.

hemolysis- lysis of erythrocytes with the release of hemoglobin.

Henry's Law- is found to be an accurate description of the behavior of gases dissolving in liquids when concentrations and partial pressures are reasonably low.

hepatotoxin- toxic to the liver.

herpetofauna– reptiles and amphibians.

horticulture- a simple form of agriculture based on working small plots of land without the use of draft animals, plows, or irrigation.

hydrocarbon- an organic compound containing only carbon and hydrogen often occurring in petroleum, natural gas, and coal.

hydrolysis- a chemical decomposition practice involving the breaking of a bond and the addition of the hydrogen cation and the hydroxide.

hydrophobic- repelling, tending not to combine with, or incapable of dissolving in water.

hygroscopic- adsorbs moisture.

hyperphosphatemia- caused by increased absorption, decreased loss (renal failure) or increased production (cell destruction).

hypoactive- abnormally inactive.

hypocalcemia- lack of calcium in the blood.

hypoglycemia- abnormal decrease of sugar in the blood.

hypopyon- layering out of white blood cells in anterior chamber .

I

igneous rock- called fire rocks and are formed either underground or above ground.

impermeable- Describes soil or rock that does not allow the movement or passage of water.

indigenous people- belonging to a place: the original inhabitants of a region or country.

indigenous plant- a native species occurring or living naturally in a particular area or environment.

inert- not readily reactive with other elements; forming few or no chemical compounds.

inoculum- the introduction of a pathogen or antigen into a living organism to stimulate the production of antibodies

insecticide– any chemical substance used to prevent, destroy, or repel insects

insectivorous– feeding on insects.

iinfiltrate- pass into or through by filtering or permeating.

influenza- an acute contagious viral infection characterized by inflammation of the respiratory tract and by fever, chills, and muscular pain.

infrastructure- Refers to transportation, utility and communication systems which are necessary for buildings, organizations, and communities to function.

Integrated Training Area Management (ITAM)- an Army land monitoring and management program mandated for all Department of Defense installations to ensure training capability and provide a realistic landscape with least impact on the environment.

intermittent noise– not continuous, with perceptible gaps between sounds.

intrauterine- occurring within the uterus.

intraperitoneal- administered by entering the peritoneum.

intravenous- entering by way of a vein.

intrusive- an artifact or feature found within a feature, component or stratum of which it was not originally a part.

ion-exchange- a process in which ions are exchanged between a solution and an insoluble solid.

irritant- a chemical, which is not corrosive but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact.

J

jurisdiction- the limits or territory where the power or right of authority may be exercised.

K

keratitis- inflammation of the cornea of the eye.

L

Land Condition Trend Analysis (LCTA)- LCTA provides for the monitoring of installation training and testing areas. The primary purpose of the LCTA component is to provide information and recommendations to managers and trainers, based on land condition.

land holding- property in land.

laser- Any of several devices that emit highly amplified and coherent radiation of one or more discrete frequencies.

latitude- a region of the earth considered in relation to its distance from the equator.

lethal cocentraion (LC_{50})- a chemical concentration that is lethal to fifty percent of a test population.

lethal dose (LD_{50})- a chemical dose lethal to fifty percent of a test population.

lethality- the quality or condition of causing death.

lethargic- not very alert or active.

leucopenia- an abnormal lowering of the white blood cell count.

lithic- made of or pertaining to stone.

loam- a loose fertile soil consisting of a balanced mixture of clay, sand and decomposed organic matter.

M

maximum contaminant level- (MCL) maximum level of a contaminant allowed in water by Federal law. Based

on health effects and currently available treatment methods.

megafauna- large or relatively large animals, as of a particular region or period, considered as a group.

metabolite- a product of metabolism.

metamorphic rocks- are rocks that have "morphed" into another kind of rock. These rocks were once igneous or sedimentary rocks.

metamorphism- the process of changing the characteristics of a rock in response to changes in temperature, pressure, or volatile content.

methemoglobinemia- presence of methemoglobin in the blood.

meteorological– dealing with the weather and weather conditions.

microclimatic- the essentially uniform local climate of a usually small site.

migration corridors- broad but well defined migration routes used by migrating birds, especially waterfowl.

mitigation- steps taken to minimize the negative effects of an action.

Modified Mercalli Intensity Scale- An earthquake intensity scale that divides the effects of an earthquake into twelve categories, from I (not felt by people) to XII (damage total).

monomer- a simple molecular unit where a polymer can be made.

monovalent compound- having a valence of one.

montmorillonite- is a member of the general mineral group the clays

mulching- a temporary soil stabilization or erosion practice where materials such as grass, hay, woodchips, wood fibers, straw, or gravel are placed on the soil surface.

munitions- all type of armament, including weapons utilized during combat or designed for training of the armed forces for inflicting or aiding in inflicting damage to the neutralization of enemy personnel, equipment, or facilities. It includes such items as bombs, rockets, smokes, incendiaries, and non-explosive practice, and training devices.

N

nanocrystalline materials- are polycryalline materials with grain size of up to 100 nm.

neonatal- affecting the newborn and especially the human infant during the first month after birth.

nephrotoxin- is a toxic agent or substance that inhibits, damages or destroys the cells and/or tissues of the kidneys.

neural system- nervous system.

neurotoxin- a toxic agent or substance that inhibits, damages or destroys the tissues of the nervous system.

nitrogen- a colorless tasteless odorless element; as a diatomic gas, it constitutes 78 percent of the atmosphere by volume and occurs as a constituent of all living tissues.

nitrogen dioxide- a toxic reddish brown gas (NO_2) and an air pollutant. It is produced by burning of fossil fuels.

nomenclature- an international standardized system of new Latin names used in biology for groups of organisms.

non-ionizing radiation- lower energy electromagnetic radiation, mostly in microwave and thermal wavelengths.

nutrification- excessive application of fertilizers to soil and water.

O

obscurant- smoke, particulate matter, fiber or other material used directly on or near the enemy with the primary purpose of suppressing observers and minimizing the enemy's vision both within and beyond their position area.

occupational exposure- exposure received during work or related occupation.

ochric- epipedons that are too light in color, too low in organic carbon, or too thin to belong to mollic, umbric, anthropic, plaggen, or histic epipedons.

omnivorous- eating both animal and vegetable foods.

opacification-the process of becoming cloudy or opaque.

ophthalmology- branch of medical science dealing with the structure, functions, and diseases of the eye.

ordnance-military supplies including weapons, ammunition, combat vehicles, and maintenance equipment.

osteomalacia- a disease of adults that is characterized by softening of the bones and is analogous to rickets in the immature

oxidizer– a chemical which supplies its own oxygen and which helps other combustible material burn more readily.

oxygen deficiency- lack of oxygen

ozone- a very reactive form of oxygen that is formed naturally in the atmosphere by a photochemical reaction. It is a major air pollutant in the lower atmosphere but a beneficial component of the upper atmosphere.

P

Paleozoic- a period in the geologic time scale that spans from 570 to 245 million years ago.

parameter- one of a set of variables that can be measured quantitatively, such as temperature or pressure, that define a system.

particulates– particulate matter (PM) is a mixture of solid particles and liquid droplets in the air. These particles originate from both stationary and mobile sources and also from natural sources.

pathogenic- capable of causing disease.

Permian- a period in the geologic time scale that spans from 286 to 245 million years ago.

Pennsylvanian-a period in the geologic time scale that spans from 320 to 286 million years ago.

periodontal- a disease that attacks the gum and bone and around the teeth.

peritoneum- the smooth transparent serous membrane that lines the cavity of the abdomen of a mammal and is folded inward over the abdominal and pelvic viscera.

photo-degradation- that will decompose under exposure to certain kinds of radiant energy, esp. ultraviolet light.

photolysis- chemical decomposition by the action of radiant energy.

photolytic- chemical degradation composition by the action of radiant energy.

physiological- being in accord with or characteristic of the normal functioning of a living organism.

piedmont-a gently inclined erosion surface carved in bedrock at the base of a mountain range.

plant alliances- a classification level based upon dominant/diagnostic species, usually of the uppermost or dominant stratum.

plant associations- classification based upon additional dominant/diagnostic species from any stratum.

plant succession- the process of gradual replacement of one plant community or ecosystem by another, involving a series of changes in the plant and animal life.

playa- a dry, vegetation-free, flat area at the lowest part of an undrained desert basin, occasionally covered by shallow lakes in the wettest parts of the year.

pneumoconiosis- disease of the lungs caused by the habitual inhalation of irritants.

pollinators- the agent that moves pollen from the male anthers of a flower to the female stigma of a flower to accomplish fertilization.

polyalcohol- any alcohol that contains more than two hydroxyl groups. Glycerol is a polyol.

polycyclic organic matter (POM)- a group of chemicals produced by incomplete combustion.

polymer- a complex compound formed by the polymerization of one or more monomers.

polyvinyl chloride (PVC)- is a major thermoplastic material finding use in a very wide variety of applications and products

population- all the organisms that constitute a specific group or occur in a specified habitat.

potable- fit to drink

potentiometric surface- the level to which water will rise in a well that penetrates an aquifer.

precipitation- any form of water, such as rain, snow, sleet, or hail, that falls to the earth's surface.

precursor- a substance, cell, or cellular component from which another substance, cell, or cellular component is formed.

predator- an organism that lives by preying on other organisms.

protocol- A code of correct conduct.

phytotoxic- poisonous to plants.

Precambrian-a geological term denoting the time in Earth history prior to 570 million years ago.

pyrophoric– a material that spontaneously ignites upon exposure to air.

pyrotechnic- a combustible substance used in a firework.

Q

Quaternary alluvium- a general term for clay, silt, sand, or gravel deposited during comparatively recent geologic time by a stream or other body of running water in the bed of the stream or on its flood plain, or as a cone or fan at the base of a mountain slope.

R

radar- a method of detecting distant objects and determining their position, velocity, or other characteristics by analysis of very high frequency radio waves reflected from their surfaces.

radiation– the process of emitting radiant energy in waves of particles.

radiological- of or having to do with x-rays or the rays from radioactive substances.

raptor- bird of prey.

reactivity- reactive wastes are unstable under normal conditions. They can cause explosions, or release toxic fumes, gases, or vapors when mixed with water.

respirable- able to be taken in by breathing.

rift- a regional-scale fracture or crack in the surface of the Earth caused by extension.

riparian- relating to the banks and plains associated with a natural watercourse, lake, or tidewater.

rodenticide- kills, repels, or controls rodents.

S

salinity- of or containing any of the salts of the alkali metals or magnesium.

scabies- a contagious skin disease caused by a parasitic mite.

secondary maximum contaminant level (SMCL)- non-enforceable drinking water guidelines for aesthetic considerations, such as taste, color and odor. These contaminants are not considered to present a risk to human health.

sedentary- settling permanently in one place.

sedentism- the practice of establishing a permanent, year-round settlement.

sedimentary rocks- are those rocks which form at or near the earth's surface at relatively low temperatures and pressures primarily.

seismic- of or having to do with earthquakes or earth vibrations, including those that are man-made, e.g., explosions.

seismicity- the geographic and historical distribution of earthquakes.

shale- a rock composed of layers of claylike fine-grained sediments.

silicosis- pneumoconiosis characterized by massive fibrosis of the lungs resulting in shortness of breath and caused by prolonged inhalation of silica dusts

silt fences- a temporary measure for sediment control, usually consisting of filter fabric stretched across posts.

simulant- see biological simulant and chemical simulant.

socioeconomic- a combination of social and economic factors such as

health, income, education, employment, and population.

soil-mapping unit- an area of soil that differs in some way from all others in a survey area and is uniquely identified on a soil map.

somnolence- being drowsy.

sonic boom- an explosive sound that results when the cone-shaped shock wave caused by a object, as an airplane, traveling at super-sonic speed touches the ground.

spodic- a soil horizon that has been enriched with organic matter, iron, and aluminum from the overlying horizons.

subchronic- usually used to describe studies or levels of exposure between 5 and 90 days.

subcutaneous- beneath the skin.

submunitions- submunitions classified as bomblets, grenades, or mines. They are small explosive-filled items designed for saturation coverage of a large area. Submunitions are generally spread out over a target area by, rockets, missiles, or projectiles.

subsistence- livelihood; the means by which an individual or group maintains life; means of obtaining food and resources.

sulfur dioxide- a heavy pungent toxic gas (SO_2) and an air pollutant. It condenses to a colorless liquid, is used especially in making sulfuric acid, in bleaching, as a preservative, and as a refrigerant.

synthesize- to combine or produce by synthesis

T

taggant- materials used to track the path of simulant plumes through the air.

talus- a sloping mass of rock debris at the base of a cliff.

taxa– plural of taxon

taxon- the name applied to a taxanomic group in a formal system of nomenclature.

temporal- relating to measured time.

teratogenic- causing developmental malformations.

terrestrial- living or growing on land; not aquatic.

tetrasodium salt- used as a scale and corrosion agent for water-cooling circulation and water boilers.

thermal decomposition- is a chemical reaction where a single compound breaks up into two or more simpler compounds or elements when heated.

thrombocytopenia- low platelet count.

tinnitus- ringing of the ears.

topography- the physical or natural features of a surface including its relief and the position of its natural and man-made features.

Total Dissolved Solids- (TDS) a measure of dissolved materials in water that indicates salinity. For many purposes, TDS concentration is a major limitation on the use of water.

toxicity– characteristic of hazardous wastes that are harmful or fatal when ingested or absorbed.

tracer- ammunition containing chemicals that mark the flight of projectiles by a trail of smoke or fire.

transitory- existing or lasting only a short time; short-lived or temporary.

translucent- allowing the passage of light.

trivalent compound- having a chemical valence of three.

troposphere- the lowest layer of the atmosphere located between the earth's surface to approximately 11 miles (17 kilometers) into the atmosphere.

tuberculosis- is primarily an illness of the respiratory system, and is spread by coughing and sneezing.

tumorigen- tumor forming.

U

ubiquitous- existing or being everywhere at the same time.

utilitarian- made to be primarily functional and practical, having minimal decoration.

ultraviolet- of or relating to the range of invisible radiation wavelengths from about 4 nanometers, on the border of the x-ray region, to about 380 nanometers, just beyond the violet in the visible spectrum.

understory- low growing plants that can be found beneath other plants.

unexploded ordnance (UXO)- explosive ordnance that has been primed, fused, armed, or otherwise prepared for action, and which has been activated by some means such as firing, dropping, launching, or projection, but remains unexploded, thereby presenting a hazard to operations or personnel.

unitary warhead- a single forward section on a missile, rocket or shell that generally contains an explosive charge.

Unmanned Aerial Vehicle (UAV)- a powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or nonlethal payload. Ballistic or

semiballistic vehicles, cruise missiles, and artillery projectiles are not considered unmanned aerial vehicles.

Unmanned Ground Vehicle (UGV)- autonomous and semiautonomous ground vehicles that do not carry human operators and are designed to perform a wide variety of functions including but not limited to risk/threat reduction, reconnaissance/surveillance, obstacle breaching, direct fire, and transportation missions.

V

vapor pressure- the pressure exerted by a vapor; often understood to mean saturated vapor pressure (the vapor pressure of a vapor in contact with its liquid form).

vegetation community- regional element of the vegetation that is characterized by the presence of certain dominant species.

vegetation type- A kind of existing plant community with distinguishable characteristics described in terms of present vegetation that dominates the aspect or physiognomy of the area. Examples include sagebrush, creosotebush, mesquite, shortgrass, etc.

vegetative cover- the plant or plant parts, living or dead, on the ground surface. The proportional area of ground covered by plants on a stated area.

ventricular- related to ventricle.

visual resources- include natural and constructed physical features that provide the landscape its character and value as an environmental resource. Landscape features that form a viewer's overall impression about the area include landform, vegetation, water, color, adjacent scenery, scarcity, and constructed modifications to the natural setting.

volatile organic carbon (VOC)- an organic chemical which can easily dissipate or evaporate into the air.

volatilization- to cause to pass off in vapor.

W

warhead impact targets (WITs)- impact areas specifically developed for testing tactical configuration submunitions where the fuzing system will detonate the submunition's main explosive charge. The submunitions tested in these impact areas are lethal. These areas are also designated as Phase II impact areas.

watershed- land area drained by a stream or river.

water table- the level below which the pore spaces in the soil or rock are saturated with water.

wavelength- the distance in the line of advance of a wave from any one point to the next point of corresponding phase.

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13.0 INDEX

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FINAL PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT FOR DEFENSE THREAT REDUCTION AGENCY (DTRA) ACTIVITIES ON WHITE SANDS MISSILE RANGE, NEW MEXICO

FINAL

Volume II: Supporting Appendices

Prepared by:

Defense Threat Reduction Agency
8725 John J. Kingman Road
MSC 6201
Fort Belvoir, VA 22060-6201

March 2007

CONTENTS OF VOLUME II: SUPPORTING APPENDICES

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APPENDIX A

REGULATORY REVIEW

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LAWS AND REGULATIONS APPLICABLE TO DTRA ACTIVITIES ON WSMR

The table below summarizes important laws and regulations applicable to Defense Threat Reduction Agency (DTRA) activities on White Sands Missile Range. Environments (or resources) that may be affected by certain DTRA activities are listed with the pertinent laws or regulations. Examples of activities include the testing of chemical and biological simulants, construction and demolition of target structures, use equipment that generate air emissions, use and storage of hazardous materials, and hazardous waste management.

REGULATION/ REGULATORY AUTHORITY	APPLICABILITY TO DTRA ACTIVITIES	SPECIFIC REQUIREMENTS
AIR:		
Clean Air Act Amendments of 1990 and New Mexico State Air Quality Regulations (20 NMAC 2.70, 2.72, 2.73, 2.74) / EPA, State AR 200-1, Chapter 6: Air Program; DA PAM 200-1, Chapter 6: Air Program / Army, WSMR	• Concrete batch plant • Construction/demolition • Vehicle and equipment emissions • Open detonations • Chemical and biological simulant releases • Fuel dispensing • Painting • Portable Generators	• New Mexico State Air Quality Regulations and the Clean Air Act Title V regulate air emission sources. These regulations outline the requirements for state-issued operating permits that are in turn enforced by federal regulations. DTRA sources included on the permit include the concrete batch plant and fuel dispensing operations. Certain recordkeeping tasks and monitoring of emissions are also to be reported every 6 months under the permit. • For any new generator, or for a generator that is changed-out or replaced, the following information must be reported to WS-ES: project name; project description; point-of-contact (name, phone number, fax, e-mail); item description; make; model number; serial number; capacity (kW); estimated kW-hr/yr; fuel type; proposed location; and if applicable, current emission unit number. • If any DTRA-related emission sources are to be modified or added, WSMR must be notified of the change to keep the permit in compliance. • Comply with all applicable Federal, State, and local requirements including, when required, a Federal Title V permit. • Procure equipment that meets air quality standards. • Cooperate with applicable authorities in achieving goals of implementation plans. • Monitor sources of regulated pollutants to ensure compliance. • Identify sources of air emissions and amount of pollutants being emitted as required.

REGULATION/ REGULATORY AUTHORITY	APPLICABILITY TO DTRA ACTIVITIES	SPECIFIC REQUIREMENTS
WATER:		
Clean Water Act (Federal Water Pollution Control Act) and New Mexico Water Quality Regulations (20 NMAC 6.2: Ground and Surface Water Protection) / EPA, State Clean Water Act, Section 311; 40 CFR 112 and 40 CFR 113 / EPA AR 200-1, Chapter 2: Water Resources Management Program; DA PAM 200-1, Chapter 2: Water Resources / Army, WSMR	• Concrete batch plant • Construction • Spills • Any discharge of a contaminant • Aboveground Storage Tanks	Under 20 NMAC 6.2: • A notice must be filed with the Ground Water Protection and Remediation Bureau for discharges of contaminants that may affect ground water and/or surface water. • Prepare a discharge plan if required by the State. • All aboveground storage tanks must have a secondary containment system for the entire contents of tank plus sufficient freeboard to allow for precipitation. • Tanks must undergo periodic testing and written records must be kept.

REGULATION/ REGULATORY AUTHORITY	APPLICABILITY TO DTRA ACTIVITIES	SPECIFIC REQUIREMENTS
CULTURAL RESOURCES:		
Archaeological Resources Protection Act / WSMR American Indian Religious Freedom Act of 1978 / WSMR Executive Order 13007: Sacred Indian Sites / WSMR Antiquities Act of 1906 / WSMR AR 200-4: Cultural Resources / Army, WSMR	• All activities	• No unauthorized excavation, removal, damage, alteration, or defacement of archaeological resources. • Native Americans cannot be denied access to sacred sites. • Must avoid adversely affecting the physical integrity of Native American Sacred sites. • Any prehistoric or historic ruins on lands owned or controlled by the U.S. government shall not be destroyed. • Early coordination of project activities with cultural resources staff is necessary to identify compliance requirements.
National Historic Preservation Act of 1966 as amended 1992 and 36 CFR 800 (implements Sections 106 and 110) / SHPO, Advisory Council on Historic Preservation	• Construction • Other ground-disturbing activities	• Section 106: must take into account the effect of undertakings on NRHP and NRHP eligible sites. • Section 110: must take into account effects of National Historic Landmarks • Must give the Advisory Council opportunity to comment
National Historic Landmarks Program (36 CFR 65) / NPS, Dept. of the Interior	• Construction • Other activities that could impact any part of the Trinity National Historic Landmark	• National Historic Landmarks are listed on the National Register of Historic Places. As listed properties they are subject to Section 106 and 110 of the National Historic Preservation Act.

REGULATION/ REGULATORY AUTHORITY	APPLICABILITY TO DTRA ACTIVITIES	SPECIFIC REQUIREMENTS
CULTURAL RESOURCES (Continued):		
Native American Graves and Repatriation Act of 1990 / WSMR	• Construction • Other activities that might unearth Native American remains	• All activity must cease and appropriate authorities notified when Native American remains are unearthed.
NATURAL RESOURCES:		
Endangered Species Act / U. S. Fish and Wildlife, NM Department of Game and Fish; NM Forestry and Resources Conversation Division Migratory Bird Treaty Act (50 CFR 10-26) / U. S. Fish and Wildlife AR 200-3: Natural Resources: Land, Forest, and Wildlife Management / Army, WSMR	• All activities	• Requires Section 7 consultation with the appropriate authorities to ensure the protection of endangered species and critical habitat. • Prohibits activities that would harm migratory birds, their nests, or their eggs. • Early coordination of projects with natural resources staff is necessary to identify compliance requirements.
Fish and Wildlife Coordination Act of 1946 / U. S. Fish and Wildlife, USACE	• Any activity likely to impact intermittent streams	• Requires consultation with USFW to prevent loss of and damage to wildlife resources.

REGULATION/ REGULATORY AUTHORITY	APPLICABILITY TO DTRA ACTIVITIES	SPECIFIC REQUIREMENTS
SOLID AND HAZARDOUS WASTE:		
Resource Conservation and Recovery Act, Subtitle D; Solid Waste Disposal Act; 20 NMAC 9.1: Solid Waste Management / State EPA Executive Order 12088: Federal Compliance with Pollution Standards	• Landfill	• Federal facilities must comply with federal, state and local requirements concerning disposal and management of solid waste. • Open dumping is prohibited. • The PHETS landfill is for construction and demolition debris. According to 20 NMAC 9 Sec. 108 they are most likely eligible for an exemption. • Federally owned and operated facilities must comply with all applicable pollution control requirements.
Resource Conservation and Recovery Act, Subtitle C: Hazardous Waste Management; 20 NMAC 4.1: Hazardous Waste Management / EPA WSMR Regulation 200-1: Hazardous Waste Management; AR 200-1, Chapter 5: Hazardous and Solid Waste Management; DA PAM 200-1, Chapter 5: Hazardous and Solid Waste Management / Army, WSMR Executive Order 12088: Federal Compliance with Pollution Standards	• Hazardous Waste	• Hazardous wastes must be properly identified and managed (40 CFR 262.11). • Waste generators must notify EPA or authorized state of their hazardous waste management activities and obtain an EPA identification number (40 CFR 262.12). • Generators must obtain a permit for waste management activities (40 CFR 264 or 265; 40 CFR 270). All treatment, storage, and disposal facilities (TSDF) must have a permit. The only exemptions to this requirement are on-site hazardous waste accumulation for less than 90 days. • Transportation, treatment, storage and disposal of hazardous waste can only be conducted with service providers having an EPA identification number (40 CFR 263). • Waste must be packaged and labeled in accordance with DOT regulations prior to transport (40 CFR 262). • Spills occurring during transport must be reported immediately (40 CFR 263) • Manifest shipments must not be stored for more than 10 days (40 CFR 263). Individuals must comply with the RCRA requirements in the performance of their assigned missions.

REGULATION/ REGULATORY AUTHORITY	APPLICABILITY TO DTRA ACTIVITIES	SPECIFIC REQUIREMENTS
SOLID AND HAZARDOUS WASTE (Continued):		
	• Hazardous Waste	• Appoint an Environmental Coordinator to act as POC for the organization's hazardous waste storage and handling. • Establish a waste management program and minimize waste generation. • Establish a 90-day accumulation point or satellite accumulation point for the temporary storage of hazardous waste. • All hazardous waste must be properly identified and packaged. • All generators of hazardous waste will ensure proper segregation of hazardous materials, hazardous waste, and recycled, recovered, or waste petroleum products. • No hazardous waste can be stored in underground storage tanks. • All generators of hazardous waste will ensure that recordkeeping requirements are met. • ENF(s)/NOV(s) will be forwarded to IC within 24 hrs. • Proper training must be provided to all personnel exposed to hazardous waste. • Hazardous waste inspections must be conducted as required. • Oil-water separators must be operated properly to ensure the recovery of oil. • All reports will be submitted to the WSMR Environmental Services Division. • Federally owned and operated facilities must comply with all applicable pollution control requirements.
Military Munitions Rule (MMR), Title 40 CFR Part 260 through 270 and Title 40 CFR Part 266, Subpart M: Hazardous Waste Management / EPA	• Activities involving military munitions.	• The Military Munitions Rule identifies when conventional and chemical military munitions become solid wastes potentially subject to hazardous waste regulation under RCRA. • In the rule, the EPA addresses munition safe handling practices, training exercises, emergency responses, and transportation and storage management standards for waste military munitions. • EPA may authorize a state to administer and enforce the RCRA hazardous waste program. Should a state RCRA program be "approved" by the EPA, the state can impose regulatory standards that are more stringent or more extensive in scope than the federal program.

REGULATION/ REGULATORY AUTHORITY	APPLICABILITY TO DTRA ACTIVITIES	SPECIFIC REQUIREMENTS
SOLID AND HAZARDOUS WASTE (Continued):		
Executive Order 13101: Greening the Government through Waste Prevention, Recycling, and Federal Acquisition; and Pollution Prevention Act	• All activities	• Waste prevention and recycling must be incorporated into daily activities. • Pollution prevention is the preferred policy when feasible, if pollution cannot be prevented then recycling is the next best alternative. Disposal should be used only as a last resort. • If an annual TRI Form R is submitted, must also submit a toxic chemical source reduction and recycling report.
HAZARDOUS MATERIALS:		
Hazardous Materials Transportation Safety Act; 49 CFR 172; and 49 CFR 177 / USDOT	• Transportation of hazardous materials	• All hazardous materials to be transported must have the proper shipping papers. • Packages of hazardous materials must be properly labeled. • Bulk packaging must be marked with identification numbers. • Vehicles must be properly placarded. • Emergency response information must be available. • Employees involved in the transportation of hazardous materials must be properly trained.
Occupational Health and Safety Act 29 CFR 1910.1200 / OSHA	• All employees working with hazardous materials	• Information about hazardous materials must be communicated to all personnel working with them. • Develop and maintain a written hazardous communications plan that includes lists of hazardous chemicals present, labeling of containers, MSDS sheets, and personnel training programs.

REGULATION/ REGULATORY AUTHORITY	APPLICABILITY TO DTRA ACTIVITIES	SPECIFIC REQUIREMENTS
HAZARDOUS MATERIALS (Continued):		
Occupational Health and Safety Act 29 CFR 1910.106 / OSHA	• Storage of flammable/ combustible materials	• Containers must be stored and handled in a way that does not cause damage to the container or label, does not block exits, and does not create a fire hazard. • Storage cabinets must be fire resistant and labeled as flammable. • Storage rooms must be fire resistant and have a containment system in case of spills. • Warehouses or storage buildings must have 3 ft wide aisles and materials must be stacked on pallets. Fire protection must be provided. • If stored outside, no more than 1100 gallons of liquid may be stored adjacent to a building. If more than 1100 gallons are being stored, there must be at least 10 ft between the storage area and buildings. Secondary containment must be provided in case of spills.
Emergency Planning and Community Right to Know; 40 CFR 355: Emergency Planning and Notification; 40 CFR 370: Hazardous Chemical Reporting; 40 CFR 372: Toxic Chemical Release Reporting / EPA 7 CFR 340: Restrictions on the Introduction of Regulated Articles / USDA	• Chemical Simulants (Phenol is listed in 40 CFR 355 and 40 CFR 302.4) • Certain biological simulants (e.g., Erwinia Herbicola)	• Must provide local emergency planning districts with a list or MSDS sheet of all hazardous materials stored on site. • Toxic Release Inventory (TRI) of toxic chemical releases must be conducted and submitted annually to the EPA and state agencies. Testing of munitions is exempt from this requirement according to the EPCRA Munitions Reporting Handbook for the U.S. Army. • A permit is required for releases into the environment of regulated articles. An application must be submitted at least 120 days in advance of the proposed release.

REGULATION/ REGULATORY AUTHORITY	APPLICABILITY TO DTRA ACTIVITIES	SPECIFIC REQUIREMENTS
HAZARDOUS MATERIALS (Continued):		
AR 200-1, Chapter 3: Oil and Hazardous Substance Spills; DA PAM 200-1, Chapter 3: Oil and Hazardous Substance Spills / Army, WSMR AR 200-1, Chapter 4: Hazardous Materials Management; DA PAM 200-1, Chapter 4: Hazardous Materials Management / Army, WSMR	• Oil and used oil • Hazardous materials • Aboveground Storage Tanks	• Prohibit discharge of oil and hazardous substances into the environment. • All oil/hazardous storage facilities/systems must have a secondary containment system. • Report spills to the appropriate personnel. • Maintain written spill notification procedures. • Maintain written spill response procedures. • Maintain a current inventory of hazardous materials. • When transporting hazardous materials in areas accessible to the general public do so safely and in a manner that will prevent spills. • Hazardous materials storage must be designed to prevent releases to the environment. • Dispose of hazardous materials and containers as directed by the environmental coordinator. • Manage excess hazardous materials through waste minimization techniques such as reuse, recycling, energy recovery, and detoxification.

REGULATION/ REGULATORY AUTHORITY	APPLICABILITY TO DTRA ACTIVITIES	SPECIFIC REQUIREMENTS
HAZARDOUS MATERIALS (Continued):		
AR 385-64; DA PAM 385-64, Ammunitions and Explosives Safety Standards / Army, WSMR Storage of Explosives and Blasting Agents (29 CFR 1910.109) / OSHA	• Stored Blasting Agents and Explosives	• Ammunition and explosives can only be stored in licensed areas. Quantities stored cannot exceed the amounts authorized on the license (AR 385-64, Chapter 6) • Explosive licenses are documents that outline the ammunition or explosives area, the facility location, the type of facility, the HD authorized and allowable limits. Licenses are permanent documents with no expiration date, however any changes in the original license will necessitate cancellation of the old license and issuance of a new license (DA PAM 385-64, Chapter 9: Explosives Licensing). • Explosives and ammunition should be stored in buildings designed, designated, and isolated for this purpose (DA PAM 385-64, Chapter 13: Explosives Storage Requirements). • Blasting caps, electric blasting caps, detonating primers, and primed cartridges shall not be stored in the same magazine with other explosives. • Class I magazines shall be required where the quantity of explosives stored is more than 50 pounds. Class II magazines are required when less than 50 pounds are being stored. • Magazines shall be weather resistant, fire-resistant, and have adequate ventilation. For storage of Class A explosives the magazine must also be bullet resistant. • Signs stating “Explosives – Keep Off” must be posted. • Specific building requirements for Class I magazines are outlined in 29 CFR 1910.109(c)(3) and for Class II magazines they are in 29 CFR 1910.109 (c)(4).
HIGH EXPLOSIVE TEST ACTIVITIES		
Comprehensive Nuclear Test Ban Treaty (CTBT)	• High Explosive Tests	• Bans all nuclear explosions whether for weapons or peaceful purposes. • Each State Party shall, on a voluntary basis, provide the Technical Secretariat with notification of any chemical explosion using 300 tons or greater of TNT-equivalent blasting material detonated as a single explosion anywhere on its territory, or at any place under its jurisdiction or control.

APPENDIX B

PUBLIC AND REGULATORY AGENCY COMMENTS

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Table of Contents

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Public Scoping Comments 2003

Mescalero Apache Tribal Historic Preservation Office

MESCALERO APACHE TRIBAL HISTORIC PRESERVATION OFFICE
P.O. Box 227
Mescalero, New Mexico 88340
Phone: 505/464-4494 ext. 270 or 279
Fax: 505/464-9270

Ms. Teresa Gepner
Environment, Safety, and Health
Defense Threat Reduction Agency
8725 John J Kingman Road MS 6201
Ft. Belvoir, VA 22060-6201

(X) The ***Mescalero Apache Tribe*** has determined that the proposed PEIS for the Expansion of Test Activities at WSMR **WILL NOT AFFECT** any objects, sites, or locations important to our traditional culture or religion.

( ) The ***Mescalero Apache Tribe*** has determined that the proposed __________ by_______ **WILL AFFECT** objects, sites, or locations important to our traditional culture or religion. We request that the _______________ undertake further consultations to evaluate the effects of the project on these sites.

In the future, we request that you minimally provide us with the following items to aid in our determination:

- Cultural Resource Survey Reports
- Site Forms
- Maps (Both General and Site Specific)
- Research Designs (If Applicable)
- Data Recovery Plans (If Applicable)
- Photographs

Thank you for providing the Mescalero Apache Tribe the opportunity to comment on this project. We look forward to reviewing and commenting on future DTRA projects.

CONCUR:

Donna Stern-McFadden
Name

Donna Stern McFadden
Signature

8/14/03
Date

Tribal Historic Preservation Officer
Title

COMMENTS:____

Mescalero Apache Tribe

Public Scoping Comments 2003

United States Department of the Interior, Fish and Wildlife Service

SEP 10 2003

SEP 10 2003

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New Mexico Ecological Services Field Office
2105 Osuna NE
Albuquerque, New Mexico 87113
Phone: (505) 346-2525 Fax: (505) 346-2542

August 29, 2003

Cons. # 2-22-03-I-657

Teresa Gepner, Chief
U.S. Department of Defense
Defense Threat Reduction Agency
8725 John J Kingman Road MS 6201
Ft. Belvoir, Virginia 22060-6201

Dear Ms. Gepner:

This responds to your July 25, 2003, letter requesting information on threatened or endangered species or important wildlife habitats that could be affected by the proposed Programmatic Environmental Impact Statement (PEIS) for expanded test activities at White Sands Missile Range (WSMR), New Mexico. The PEIS will address: 1) the continued operation and maintenance of test structures used as targets for weapon systems evaluations; 2) construction of new test structures, enlargement of existing test beds, and development of new test beds; 3) testing, operations, and maintenance activities at tunnel targets in the Capitol Peak area; 4) the use of increased quantities and an expanded selection of simulants in collateral effects tests at additional WSMR locations; and 5) improvements to the Defense Threat Reduction Agency's test operations support facilities at WSMR.

We have enclosed a current list of federally endangered, threatened, proposed, and candidate species, and species of concern that may be found in Doña Ana County, Lincoln, Otero, Sierra, and Socorro County, New Mexico.[1] Under the Endangered Species Act, as amended (Act), it is the responsibility of the Federal action agency or its designated representative to determine if a proposed action "may affect" endangered, threatened, or proposed species, or designated critical habitat, and if so, to consult with us further. If your action area has suitable habitat for any of these species, we recommend that species-specific surveys be conducted during the flowering season for plants and at the appropriate time for wildlife to evaluate any possible project-related impacts. Please keep in mind that the scope of federally listed species compliance also includes any interrelated or interdependent project activities (e.g., equipment staging areas, offsite borrow material areas, or utility relocations) and any indirect or cumulative effects.

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[1] Additional information about these species is available on the Internet at <http://nmrareplants.unm.edu>, <http://nmnhp.unm.edu/bisonm/bisonquery.php>, and <http://ifw2es.fws.gov/endangeredspecies>.

Public Scoping Comments 2003

Teresa Gepner, Chief 2

Candidates and species of concern have no legal protection under the Act and are included in this document for planning purposes only. We monitor the status of these species. If significant declines are detected, these species could potentially be listed as endangered or threatened. Therefore, actions that may contribute to their decline should be avoided. We recommend that candidates and species of concern be included in your surveys.

Under Executive Orders 11988 and 11990, Federal agencies are required to minimize the destruction, loss, or degradation of wetlands and floodplains, and preserve and enhance their natural and beneficial values. We recommend you contact the U.S. Army Corps of Engineers for permitting requirements under section 404 of the Clean Water Act if your proposed action could impact floodplains or wetlands. These habitats should be conserved through avoidance, or mitigated to ensure no net loss of wetlands function and value.

The Migratory Bird Treaty Act (MBTA) prohibits the taking of migratory birds, nests, and eggs, except as permitted by the U.S. Fish and Wildlife Service. To minimize the likelihood of adverse impacts to all birds protected under the MBTA, we recommend construction activities occur outside the general migratory bird nesting season of March through August, or that areas proposed for construction during the nesting season be surveyed, and when occupied, avoided until nesting is complete.

With regard to fish and wildlife resources, the PEIS should assess the impacts of the proposed project and its alternatives on species populations and their habitats, with an emphasis on wetlands, waters of the United States, and native wildlife and plants. The PEIS should clearly state the purpose and need of the project, and should include a thorough description of the project area.

Thank you for your concern for New Mexico's wildlife and their habitats. We look forward to reviewing and providing comments on the draft PEIS when it becomes available. In future correspondence regarding this project, please refer to consultation # 2-22-03-I-657. If you have any questions about the information in this letter, please contact John Branstetter at the letterhead address or at (505) 761-2525 ext. 4753.

Sincerely,

Susan MacMullin

Susan MacMullin
Acting Field Supervisor

Enclosure

cc: (wo/enc)
Director, New Mexico Department of Game and Fish, Santa Fe, New Mexico
Director, New Mexico Energy, Minerals, and Natural Resources Department, Forestry Division, Santa Fe, New Mexico

Public Scoping Comments 2003

FEDERAL ENDANGERED, THREATENED,
PROPOSED, AND CANDIDATE SPECIES
AND SPECIES OF CONCERN IN NEW MEXICO
Consultation Number 2-22-03-I-657
August 29, 2003

Doña Ana County

ENDANGERED
- Interior least tern (*Sterna antillarum*)
- Northern aplomado falcon (*Falco femoralis septentrionalis*)
- Southwestern willow flycatcher (*Empidonax traillii extimus*)
- Sneed pincushion cactus (*Coryphantha sneedii* var. sneedii)

THREATENED
- Bald eagle (*Haliaeetus leucocephalus*)
- Mexican spotted owl (*Strix occidentalis lucida*)

CANDIDATE
- Yellow-billed cuckoo (*Coccyzus americanus*)

SPECIES OF CONCERN
- Desert pocket gopher (*Geomys bursarius arenarius*)
- Organ Mountains Colorado chipmunk (*Eutamias quadrivittatus australis*)
- Townsend's big-eared bat (*Corynorhinus townsendii*)
- Western red bat (*Lasiurus blossevillii*)
- Pecos River muskrat (*Ondatra zibethicus ripensis*).
- White Sands woodrat (*Neotoma micropus leucophaea*)
- American peregrine falcon (*Falco peregrinus anatum*)
- Arctic peregrine falcon (*Falco peregrinus tundrius*)
- Baird's sparrow (*Ammodramus bairdii*)
- Bell's vireo (*Vireo bellii*)
- Black tern (*Chlidonias niger*)
- Western burrowing owl (*Athene cunicularia hypugea*)
- Desert viceroy butterfly (*Limenitis archippus obsoleta*)
- Anthony blister beetle (*Lytta mirifica*)
- Doña Ana talussnail (*Sonorella todseni*)
- Alamo beard tongue (*Penstemon alamosensis*)
- Desert night-blooming cereus (*Cereus greggii* var. greggii)
- Mescalero milkwort (*Polygala rimulicola* var. mescalerorum)
- Nodding rock-daisy (*Perityle cernua*)
- Organ Mountain evening-primrose (*Oenothera organensis*)
- Organ Mountain figwort (*Scrophularia laevis*)
- Sand prickly pear (*Opuntia arenaria*)
- Sandhill goosefoot (*Chenopodium cycloides*)
- Standley whitlow-grass (*Draba standleyi*)

Public Scoping Comments 2003

Lincoln County

ENDANGERED

Black-footed ferret (*Mustela nigripes*)**
Northern aplomado falcon (*Falco femoralis septentrionalis*)
Kuenzler hedgehog cactus (*Echinocereus fendleri* var. *kuenzleri*)

THREATENED

Bald eagle (*Haliaeetus leucocephalus*)
Mexican spotted owl (*Strix occidentalis lucida*)

PROPOSED THREATENED

Mountain plover (*Charadrius montanus*)

CANDIDATE

Black-tailed prairie dog (*Cynomys ludovicianus*)

SPECIES OF CONCERN

New Mexican meadow jumping mouse (*Zapus hudsonius luteus*)
Organ Mountains Colorado chipmunk (*Eutamias quadrivittatus australis*)
Townsend's big-eared bat (*Corynorhinus townsendii*)
Pecos River muskrat (*Ondatra zibethicus ripensis*)
Penasco (Least) chipmunk, (*Tamias minimus atristriatus*)
American peregrine falcon (*Falco peregrinus anatum*)
Arctic peregrine falcon (*Falco peregrinus tundrius*)
Baird's sparrow (*Ammodramus bairdii*)
Common black hawk (*Buteogallus anthracinus*)
Northern goshawk (*Accipiter gentilis*)
Western burrowing owl (*Athene cunicularia hypugea*)
Yellow-billed cuckoo (*Coccyzus americanus*)
White Sands pupfish (*Cyprinodon tularosa*)
Sacramento mountain salamander (*Aneides hardii*)
Bonita diving beetle (*Deronectes neomexicana*)
Sacramento Mountains silverspot butterfly (*Speyeria atlantis capitanensis*)
Sacramento Mountains blue butterfly (*Icaricia icariodes*)
Desert viceroy butterfly (*Limenitis archippus obsoleta*)
Goodding's onion (*Allium gooddingii*)
Sierra Blanca cliff daisy (*Chaetopappa elegans*)
Wright's marsh thistle (*Cirsium wrightii*)

Public Scoping Comments 2003

Otero County

ENDANGERED
- Black-footed ferret (*Mustela nigripes*)**
- Interior least tern (*Sterna antillarum*)
- Northern aplomado falcon (*Falco femoralis septentrionalis*)
- Southwestern willow flycatcher (*Empidonax traillii extimus*)

ENDANGERED continued
- Kuenzler hedgehog cactus (*Echinocereus fendleri* var. *kuenzleri*)
- Sacramento prickly poppy (*Argemone pleiacantha* ssp. *pinnatisecta*)
- Todsen's pennyroyal (*Hedeoma todsenii*)

PROPOSED ENDANGERED
- Sacramento Mountains checkerspot butterfly (*Euphydryas anicia cloudcrofti*)

THREATENED
- Bald eagle (*Haliaeetus leucocephalus*)
- Mexican spotted owl (*Strix occidentalis lucida*)
- Sacramento Mountains thistle (*Cirsium vinaceum*)

PROPOSED THREATENED
- Mountain plover (*Charadrius montanus*)

CANDIDATE
- Black-tailed prairie dog (*Cynomys ludovicianus*)

SPECIES OF CONCERN
- Desert pocket gopher (*Geomys bursarius arenarius*)
- Guadalupe southern pocket gopher (*Thomomys umbrinus guadalupensis*)
- New Mexican meadow jumping mouse (*Zapus hudsonius luteus*)
- Penasco (Least) chipmunk, (*Tamias minimus atristriatus*)
- Townsend's big-eared bat (*Corynorhinus townsendii*)
- White Sands woodrat (*Neotoma micropus leucophaea*)
- American peregrine falcon (*Falco peregrinus anatum*)
- Arctic peregrine falcon (*Falco peregrinus tundrius*)
- Baird's sparrow (*Ammodramus bairdii*)
- Bell's vireo (*Vireo bellii*)
- Black tern (*Chlidonias niger*)
- Northern goshawk (*Accipiter gentilis*)
- Western burrowing owl (*Athene cunicularia hypugea*)
- Yellow-billed cuckoo (*Coccyzus americanus*)
- Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*)
- White Sands pupfish (*Cyprinodon tularosa*)
- Sacramento mountain salamander *(Aneides hardii)*
- Sacramento Mountains silverspot butterfly (*Speyeria atlantis capitanensis*)

Public Scoping Comments 2003

Sacramento Mountains blue butterfly (*Icaricia icarioides*) new subspecies
Alamo beard tongue (*Penstemon alamosensis*)
Desert night-blooming cereus (*Cereus greggii* var. *greggii*)
Goodding's onion (*Allium gooddingii*)
Guadalupe rabbitbrush (*Chrysothamnus nauseosus* var. *texensis*)
Gypsum scalebroom (*Lepidospartum burgessii*)
Sierra Blanca cliff daisy (*Chaetopappa elegans*)
Villard's pincushion cactus (*Escobaria villardii*)
Wright's marsh thistle (*Cirsium wrightii*)

Sierra County

ENDANGERED
Black-footed ferret (*Mustela nigripes*)**
Northern aplomado falcon (*Falco femoralis septentrionalis*)
Southwestern willow flycatcher (*Empidonax traillii extimus*)
Gila trout (*Oncorhynchus gilae*)
Todsen's pennyroyal (*Hedeoma todsenii*), with critical habitat

THREATENED
Bald eagle (*Haliaeetus leucocephalus*)
Mexican spotted owl (*Strix occidentalis lucida*)
Chiricahua leopard frog (*Rana chiricahuensis*)

CANDIDATE
Black-tailed prairie dog (*Cynomys ludovicianus*)*
Yellow-billed cuckoo (*Coccyzus americanus*)

SPECIES OF CONCERN
Organ Mountains Colorado chipmunk (*Eutamias quadrivittatus australis*)
Townsend's big-eared bat (*Corynorhinus townsendii*)
Southwestern otter (*Lutra canadensis sonorae*)
White Sands woodrat (*Neotoma micropus leucophaea*)
American peregrine falcon (*Falco peregrinus anatum*)
Arctic peregrine falcon (*Falco peregrinus tundrius*)
Baird's sparrow (*Ammodramus bairdii*)
Bell's vireo (*Vireo bellii*)
Black tern (*Chlidonias niger*)
Northern goshawk (*Accipiter gentilis*)
Western burrowing owl (*Athene cunicularia hypugea*)
Desert sucker (*Catostomus clarki*)
Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*)
Sonora sucker (*Catostomus insignis*)
White Sands pupfish (*Cyprinodon tularosa*)
Desert viceroy butterfly (*Limenitis archippus obsoleta*)

Public Scoping Comments 2003

Mineral Creek mountainsnail (*Oreohelix pilsbryi*)
Duncan's pincushion cactus (*Coryphantha duncanii*)
Pinos Altos flame flower (*Talinum humile*)
Sandhill goosefoot (*Chenopodium cycloides*)

Socorro County

ENDANGERED
Black-footed ferret (*Mustela nigripes*)**
Interior least tern (*Sterna antillarum*)
Northern aplomado falcon (*Falco femoralis septentrionalis*)
Southwestern willow flycatcher (*Empidonax traillii extimus*)
Rio Grande silvery minnow (*Hybognathus amarus*) with critical habitat

ENDANGERED continued
Socorro isopod (*Thermosphaeroma thermophilus*)
Alamosa springsnail (*Psuedotryonia alamosae*)
Socorro pyrg (springsnail) (*Pyrgulopsis neomexicana*)

THREATENED
Bald eagle (*Haliaeetus leucocephalus*)
Mexican spotted owl (*Strix occidentalis lucida*) with critical habitat
Piping plover (*Charadrius melodus*)
Chiricahua leopard frog (*Rana chiricahuensis*)

PROPOSED THREATENED
Mountain plover (*Charadrius montanus*)

CANDIDATE
Black-tailed prairie dog (*Cynomys ludovicianus*)
Yellow-billed cuckoo (*Coccyzus americanus*)
Chupadera pyrg (springsnail) (*Pyrgulopsis chupaderae*)

SPECIES OF CONCERN
Allen's big-eared bat (*Idionycteris phyllotis*)
Desert pocket gopher (*Geomys bursarius arenarius*)
New Mexican meadow jumping mouse (*Zapus hudsonius luteus*)
Organ Mountains Colorado chipmunk (*Eutamias quadrivittatus australis*)
Townsend's big-eared bat (*Corynorhinus townsendii*)
Pecos River muskrat (*Ondatra zibethicus ripensis*)
American peregrine falcon (*Falco peregrinus anatum*)
Arctic peregrine falcon (*Falco peregrinus tundrius*)
Baird's sparrow (*Ammodramus bairdii*)
Bell's vireo (*Vireo bellii*)
Black tern (*Chlidonias niger*)

Public Scoping Comments 2003

Northern goshawk (*Accipiter gentilis*)
Western burrowing owl (*Athene cunicularia hypugea*)
Rio Grande sucker (*Catostomus plebeius*)
Desert viceroy butterfly (*Limenitis archippus obsoleta*)
Fugate's blue-star (*Amsonia fugatei*)
Sandhill goosefoot (*Chenopodium cycloides*)

<u>Index</u>

Endangered	=	Any species which is in danger of extinction throughout all or a significant portion of its range.
Threatened	=	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
Candidate	=	Candidate Species (taxa for which the Service has sufficient information to propose that they be added to list of endangered and threatened species, but the listing action has been precluded by other higher priority listing activities).
Proposed	=	Any species of fish, wildlife or plant that is proposed in the Federal Register to be listed under section 4 of the Act.
Species of Concern	=	Taxa for which further biological research and field study are needed to resolve their conservation status <u>OR</u> are considered sensitive, rare, or declining on lists maintained by Natural Heritage Programs, State wildlife agencies, other Federal agencies, or professional/academic scientific societies. Species of Concern are included for planning purposes only.
*	=	Introduced population
**	=	Survey should be conducted if project involves impacts to prairie dog towns or complexes of 200-acres or more for the Gunnison's prairie dog (*Cynomys gunnisoni*) and/or 80-acres or more for any subspecies of Black-tailed prairie dog (*Cynomys ludovicianus*). A complex consists of two or more neighboring prairie dog towns within 4.3 miles (7 kilometers) of each other.

Public Scoping Comments 2003

Private Individuals/Organizations

Defense Threat Reduction Agency (DTRA)
Draft Programmatic Environmental Impact Statement (PEIS)
White Sands Missile Range (WSMR)
Comment Form

All comments must be post marked by September 15, 2003
(Please print)

***Name** (optional) Astrid Webster

***Organization / affiliation** (optional)

***Address** (optional) 1600 Valencia NE
Albuquerque, N.M. 87110

***Phone** (optional) 505-265-2394

***Email address** (optional) astrid[redacted]@swcp.com

***Facsimile** (optional)

Comments It is a terrible thing you are planning to do, to the environment, to humanity, to your own souls. What has the earth done to you that you want to penetrate it with these destructive weapons. The USA's willingness (nay eagerness) to fight bomb & lay waste to humans & environment alike is astounding. Geo Bush says we are fighting terrorism. Our continued escalation of arms is creating terrorists. What can people do but plan to cripple the US when we take out any of their leaders that we do not like.
The earth & its inhabitants are in great geopardy from these test. We don't need more, we need less

Thank you for your comments regarding the DTRA proposed action at WSMR. Please turn in your comments tonight or:

Mail comments to:
Defense Threat Reduction Agency
ATTN: TDTS (Public Comments)
1680 Texas Street SE
Kirtland AFB, NM 87117-5669

Email comments to: TDTS@ao.dtra.mil

Facsimile comments to: (505) 846-9670.

The Draft PEIS will be posted on the DTRA website, www.dtra.mil for downloading.

Are you interested in being on the distribution for a paper copy of the

Draft PEIS Executive Summary? YES NO (please circle)

Entire Draft PEIS document? YES NO (please circle)

***Information requested if you wish to be on the Draft PEIS mailing list. Personal information you provide will be protected pursuant to the Privacy Act, 5 U.S.C., Section 552a, and the Freedom of Information Act, 5 U.S.C., Section 552.**

Public Scoping Comments 2003

SENT AS E-MAIL on 9/9/03 at 2:34 p.m.

418 Bosquecito Road
San Antonio, NM 87832
September 9, 2003

Defense Threat Reduction Agency, Public Comments
ATTN: TDTS,
1680 Texas Street SE
Kirtland Air Force Base, NM 87117-5669

Re: Comments in re DPEIS for White Sands Missile Range, NM

To Whom It May Concern:

We live in an area virtually contiguous to the border of the Missile Testing Area, four miles north of highway 380. We estimate we are not more than 17 miles from the proposed testing areas. We wish to state our opposition to either continued or expanded testing at White Sands Missile Base for the following reasons:

1) SEISMIC ACTIVITY: A 1400 KM long earthquake fracture zone (extending from southwestern Arizona through New Mexico, across the Texas Panhandle into Oklahoma) runs along the Rio Grande River through Socorro and to The Bosque del Apache National Wildlife Preserve, where it veers northeastward. A large body of magma sits beneath Socorro at varying depths. New Mexico Technical Institute already conducts weapons tests in a mountain at the northwest of the Socorro portion of the fracture zone; numerous seismic events have persisted over the years in this area, with large earthquake swarms occurring during the 1980s. It is known that high pressure injection of chemical waste water into fractured basement rock at the Rocky Mt. Arsenal correlated with 7.0 earthquakes both in the Denver, CO area and oil fields in West Texas. A NM Tech study stated "possible explanation for the periodic bursts of seismicity in the (Socorro area) swarms could be irregular injections of fluid into the crust"*...and **"spasmatic movements of magma or water in the seismogenic crust could be the potential driving force behind the bursts of seismicity."****

   U.S. government "bunker-busting" weapons using "non-radioactive cessium" and other "simulants" equivalent to the force of nuclear weapons, deep in tunnels in this area dangerously near the active fault zone, MUST BE INVESTIGATED in terms of their potential effects upon the existing and widespread seismic activity in this area. The uncertainty as to what triggers local seismic activity should be sufficient cause for the immediate cessation of ALL testing in this area.

2) CHEMICAL TOXICITY: In the two years since we have lived in our present home, we have on several occasions been subjected to acrid, sickening odors wafting over our property (and that of other property-owners several miles away), lasting for an entire night and into the next morning. We are now convinced that these odors arose from testing already being conducted at this testing site, and we therefore object to the use of any test chemicals. Circular wind patterns in New Mexico are frequently unpredictable, with abrupt wind changes—as the U.S. Forest Service discovered in the recent fire that could have destroyed the Los Alamos Lab. THE PROPOSED "MONITORS" CANNOT PREDICT, NOR CAN THEY PROVIDE AFTER-THE FACT PROTECTION, IN THE EVENT OF SUCH UNPREDICTABLE WIND CHANGES. With such testing as is proposed, the U.S. government suggests that citizens agree to participate in a game of roulette using these experiments as gunshot.

   In addition to the possibility for human exposure, there are other unquantified threats to the environment, i.e., groundwater contamination affecting sensitive and endangered fish and bird

Public Scoping Comments 2003

populations (willow flycatchers, silvery minnow, etc.) The groundwater in the Rio Grande and surrounding area is generally just a few feet below surface. Contaminants will be carried on river water and through rainwater run-off, and infused into the soil and inevitably, the groundwater.

3) COLLATERAL DAMAGE: We have been informed by a neighbor that a large front picture window in her home sustained a large crack and required replacement – for no discernible reason. She attempted to obtain compensation from White Sands, but, after hours of being shifted from one command to another, was informed that White Sands was "not responsible" for such damage. We have recently determined that the INNER glass layer of TWO SKYLIGHT WINDOWS in our home is both cracked and broken – again for no discernible reason (there have been no supersonic flights in our area – only transports and Blackhawk refuelers).

4) CULTURAL AND HISTORICAL: The nearby Trinity Site itself -- as well as the soil for miles around the area -- were contaminated by nuclear fallout for years after the first nuclear bomb tests there. The proposed expansion to accommodate renewed nuclear testing is a terrifying reminder that the U.S. government once subjected its unsuspecting citizens to the most dangerous experimental weapons test ever conducted anywhere prior to that time. The Trinity Site continues to warn American citizens of the danger that can be imposed upon them by a thoughtless, unconcerned government. If anyone could excuse such use of governmental authority during WWII, there is certainly no such justification for it at this time.

THE WEAPONS PROPOSED FOR THIS TESTING ARE OFFENSIVE, NOT DEFENSIVE, WEAPONS. Why, therefore, is THIS agency – The Defense Threat Reduction Agency -- putting forth these offensive-weapons proposals? Is not this testing illegal under our non-nuclear proliferation treaties with other countries?

WE CAN ACCEPT NO MITIGATION OR ALTERNATIVE FOR THE TESTING OF SUCH POWERFUL AND OFFENSIVE WAR WEAPONS -- WITH SEISMIC DRIVING FORCE POTENTIAL AND USING QUESTIONABLE CHEMICALS -- IN SUCH CLOSE VICINITY OF HUMAN BEINGS AND ENDANGERED SPECIES.

We therefore respectfully urge that this EIS recommend—not only that these tests NOT be conducted—but that White Sands Missile Base REMOVE the existing structures and close down this portion of its weapons testing area permanently.

Yours truly,

Elizabeth Hillerstrom

ELIZABETH HILLERSTROM TORD HILLERSTROM

* "Earthquake Swarm Studies in the Central Rio Grande Rift: Specific and General Results," by Robert S. Balch, NM Institute of Mining and Technology, Socorro, NM 87801 April 1997, p.122

**Ibid..

Public Scoping Comments 2003

September 11, 2003

Defense Threat Reduction Agency
1680 Texas Street
Kirtland Airforce Base, NM 87117-5669

Re: public comments, DPEIS for White Sands Missile Range

To Whom It May Concern:

Having read the DTRA Fact Sheet concerning testing "bunker buster bombs," we wish to voice our serious reservations since we live within miles of the proposed testing site.

Although we do not claim to be experts in defense technologies, we are aware of the fact that these weapons do contain dangerous materials in the tips of the warheads to enhance their penetrating capability, in particular depleted uranium. There is anecdotal evidence that this element is carcinogenic and has also been linked to an array of maladies generally referred to as "Gulf War Syndrome." Because of this, it would be highly irresponsible to unleash these toxins in such close proximity to populated areas.

Furthermore, as biologists and wildlife rehabilitators, we are extremely concerned about the damage to animal populations and their habitat within the testing area. We are often the first to encounter toxicity in wildlife due to human shortsightedness when using poisons. Numerous times we have seen large bird populations wiped out due to spraying of pesticides. It is imperative to research what effects any chemicals released from these weapons might have on the creatures living near the test site as well as any destruction of habitat that might be caused by the actual explosions themselves. It must also be kept in mind that not unlike the proverbial canary in the coal mine, when we finally realize that what's affecting the birds is affecting the people, it's probably too late.

Finally, since the Socorro area is known to sit near an earthquake fracture zone, extensive study remains to be done on how these highly explosive concussions will affect the seismic activity.

As lay people, it's likely that we have overlooked many other potential hazards that the testing of these weapons may visit upon us and our neighbors, but at least these three reasons alone are enough to warrant a halt to any experimentation by your agency at the White Sands Missile Range.

Respectfully,

Matthew Mitchell   Stephanie Mitchell

Matthew Mitchell
265 Bosquecito Rd.
San Antonio, NM 87832

Stephanie Mitchell

Public Scoping Comments 2003

nuclear watch new mexico

Scoping Comments to the Defense Threat Reduction Agency On the Programmatic Environmental Impact Statement For DTRA Activities at the White Sands Missile Range

September 15, 2003

By fax to 505.846.9670 and e-mail to TDTS@ao.dtra.mil

To whom it may concern:

Nuclear Watch of New Mexico (NWNM) is pleased to submit the following scoping comments on the Programmatic Environmental Impact Statement for Defense Threat Reduction Agency Activities at White Sands Missile Range.

The stated mission of the Agency is:

> The Defense Threat Reduction Agency [DTRA] safeguards America's interests from weapons of mass destruction (chemical, biological, radiological, nuclear and high explosives) by controlling and reducing the threat and providing quality tools and services for the warfighter.

In our view, there is currently an over-reliance by the U.S. government on *counterproliferation* (warfighting against potential threats) vs. *nonproliferation* (that is largely pre-empting potential WMD threats through diplomacy, binding treaty regimes and providing global leadership by example). While it is incontestable that the U.S. has quantitatively reduced its WMDs, the same cannot be said for a qualitative reduction of its arsenal of the most destructive and militarily useful WMDs (i.e., nuclear weapons). This is particularly true given the recent programmatic and legislative pushes towards developing a new Robust Nuclear Earth Penetrator (RNEP) and the so-called mini-nukes, issues which we suspect may be partially in play in this PEIS.

It is interesting to note that the current DTRA Director was formerly the senior associate director for national security affairs at the Los Alamos National Laboratory (LANL). He was also (still is?) a leading proponent for the revised "deterrence" capabilities of nuclear weapons. LANL and its sister lab the Lawrence Livermore National Laboratory have already formed "red teams" for RNEP design. It is also interesting that the DTRA web site prominently features what appears to be a nuclear-certified B-2 bomber test dropping a B61-11, the most recent modification of a nuclear earth-penetrator.

We would like to think that we are not naïve - - we concur that some counterproliferation "tools and services" are indeed needed. However, Nuclear Watch of New Mexico argues that the

551 West Cordova Road #808 Santa Fe, New Mexico 87505 505.989.7342 Fax 505.989.7352
info@nukewatch.org www.nukewatch.org

We would like to think that we are not naïve - - we concur that some counterproliferation "tools and services" are indeed needed. However, Nuclear Watch of New Mexico argues that the overwhelming emphasis given to counterproliferation actually works against our national security interests. We think this will inevitably lead to other nations concluding that they must have their own WMDs as deterrence against the U.S., thereby directly undermining our national security. We contend this is already being demonstrated by current international events that are unfortunately being exacerbated and accelerated by the newly declared policy of pre-emptive strikes when deemed necessary.

Commenting on DTRA issues is new to us, but we do have extensive experience in commenting on Department of Energy (DOE) issues. Like DOE, we suspect that the Defense Threat Reduction Agency will hasten to point to various presidential directives to justify its work. What we think DTRA should do in this draft PEIS is to offer a stringent evaluation of what is in the country's best interests. The question is: is it better to put an overwhelming emphasis on counterproliferation, or is it better to strengthen the global nonproliferation regime through concrete, near-term example? We think there is compelling urgency to this question, as the global nonproliferation regime appears to be reaching a current near-terminal crisis. We submit this is in large due to the emphasis of counterproliferation over nonproliferation.

Specific issues or questions that DTRA should address in the WSMR PEIS:

- The Agency fact sheet states that "DTRA conducts tests [at WSMR] to evaluate the lethality of conventional and advanced weapons against various targets." Conventional weapons are commonly understood to be high explosives. Please describe the types and categories of "unconventional" or "advanced" weapons systems (e.g., "highly energetic," thermobaric, electromagnetic pulse, nuclear, etc.) to be used in future tests.

- To what extent would DTRA activities at the WSMR dovetail with the RNEP initiatives at the nuclear weapons design labs (LANL, Lawrence Livermore and Sandia)? Please describe in full any relationship between the DOE labs and DTRA activities at the WSMR (including both nuclear and non-nuclear initiatives).

- Given that the mailing address for these comments is for Kirtland AFB, please describe the DTRA presence there. Additionally, what is DTRA's relationship, if any, with the Air Force Space Weapons Lab (formerly the Phillips Lab) at Kirtland AFB?

- The DTRA fact sheet states that "[m]ock enemy targets, including deeply buried and concrete-reinforced structures are used to test weapon systems." How deeply buried? What are the varied geologic features that DTRA plans to test in (e.g., sand, alluvium, granite, etc?).

- The DTRA fact sheet states that "[t]hese tests help reduce the effects that an attack on a WMD facility could cause on nearby areas." In the event of an attack on a biological weapons facility mere reduction may not be enough. How is complete destruction of a stock of bioweapons select agents to be assured? What is the role of future tests in that assurance?

- Assuming that these tests could be related to RNEP development, how can they help to reduce collateral effects when that damage will be a function of the attack itself (i.e., directly

Public Scoping Comments 2003

related to the yield of the nuclear warhead)? For that matter, what range of yields is being contemplated for the RNEP?

- The DTRA fact sheet states that the "use of increased quantities and an expanded selection of simulants in collateral test effect at additional WSMR locations" will be addressed. What is the complete list and description of these simulants and what pathogens or toxins are they simulating?

- What monitoring systems will be in place for tests on all forms of targets? The planned activities appear to dictate the need for the monitoring of biological simulants, chemicals and radiological materials. What are the spectrum and quantities of chemicals to be used in tests? What are the spectrum and quantities of radiological materials to be used in these tests? Would the actual chemicals and radiological materials be used, or would they also be simulated?

- Do any hardened deeply buried targets or tunnel tests require the use of any artillery, gravity bombs or missiles (both nuclear and nonnuclear)? Would unarmed RNEPs or replicas thereof be used in tests at WSMR? If any missiles are to be involved in any tests, from where would they be launched?

- To what extent, if any, is there any redundancy in planned tests and facilities between the WSMR and the Tonapah Test Range?

- What is the geologic setting of any tunnel targets tests? What is their applicability to potential targets in other countries?

- How powerful are explosive tests to be?

These constitute our comments and questions for now. We look forward to commenting on the Draft PEIS, which should provide the opportunity for more substantive discussion. Please keep us informed and please provide us with the Draft WSMR PEIS at the earliest opportunity.

Respectfully submitted,

Jay Coghlan
Jay Coghlan,
Director

Contact info: Nuclear Watch of New Mexico
551 W. Cordova Rd., #808
Santa Fe, New Mexico 87505
505.989.7342
info@nukewatch.org

Public Scoping Transcripts 2003

Transcription of Videotape PEIS Briefing, 12 August 2003 Las Cruces, New Mexico

1

TRANSCRIPTION OF VIDEOTAPE

PEIS BRIEFING, 12 AUG 03

LAS CRUCES, NEW MEXICO

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SHERRY: Thank you for coming. Thank you for your interest in our project. We are here for the program I can environmental impact statement of the Defense Threat Reduction Agency is conducting at White Sands Missile Range, and I'd like to introduce you to some of the main speakers we have this evening. First, I'll go through the schedule. This is the public meeting scheduled. This is the first of the three public meetings that we'll be holding in New Mexico this week.

We have two speakers that will be up here talking to you this evening, Colonel Chuck Thomas -- Colonel Thomas, could you stand -- he is the chief of our test and technology support division here in New Mexico for the technology development directorate of the Defense Threat Reduction Agency.

We also have Mr. Mike Demko. He is the chief of environmental safety and health branch from Albuquerque, and he is stationed at White Sands -- I'm sorry -- at Kirtland Air Force Base.

We also have Colonel Thomas Van Osteen. He is the environmental engineer. Lindy Ford is here from White Sands Missile Range, and he is an environmental engineer. Would you mind standing. Thank you. And we also have Russ Procure. He is an

Public Scoping Transcripts 2003

environmental scientist from White Sands Missile Range. Debbie Bingham for public affairs at White Sands Missile Range.

And this presentation is going to be videotaped as a matter of public record by our agency, and Sergeant Joe (indiscernible) from the Defense Threat Reduction Agency is taping this.

We are here this evening to discuss current and proposed test activities that the Defense Threat Reduction Agency is currently testing at White Sands Missile Range, and also proposed tests, and to discuss the national environmental policy management process and procedure.

We do have a sign-up outside. If you're interested in making comments, you're welcome to sign up. We ask that if it's possible, you would keep your questions until the end of the presentation. If you do want to speak, we would ask that you limit your talk to about ten minutes so that others can speak.

Basically, we're here to explain to you what we are doing, what we plan to do, and to get your comments. Colonel Thomas.

COLONEL THOMAS: Well, good evening. I'm Colonel Chuck Thomas, and I'm the chief of the division that does the testing, which is responsible for the

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:26:51 scheduling and coordination and the execution of the tests that go on at White Sands with the Defense Threat Reduction Agency. And I want to take just a few minutes to explain what our role is in this process.

:27:04 A lot of people are continually asking, what is the Defense Threat Reduction Agency, what is our mission, what are we here to do? Simply put, our mission is to make the world safer by reducing the threat of weapons of mass destruction. And weapons of

:27:20 mass destruction are those chemical, biological, radiological, nuclear, high explosive weapons and threats that you read about every day.

And our specific charter, as a combat support agency, is to provide the war fighters the

:28:32 capability to defend that threat, therefore, making the world safer. We are a combat support agency, which means that we are directly responsible for working with the combatant commanders, or what used to be, in the old terminology, the CinCs, you know, the commanders in

30:07 chief. These are the senior military generals who are in the theater. So, we're responsible for them, to provide them that capability.

And we are organized with approximately 2,000 folks, actually 50 percent military, 50 percent

32:39 civilian, with a budget of approximately $2 billion,

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:33:06 50 million directly related to activities here in New Mexico. We are the near-term interface which provides those war fighters research and development capability. And particularly since September 11, we've been given a
:33:45 mission as a go-to agency to provide those war fighters that capability, sometimes in real quick time.

The mission of the Defense Threat Reduction Agency, particularly in New Mexico, spans these five elements. First of all, arms control.
:34:07 Defense Threat Reduction Agency provides specially trained personnel to do the inspection criteria to ensure that weapons of mass destruction don't come into the United States through our national borders.

Additionally, we have a threat reduction
:34:27 component, which helps the former Soviet Union dismantle their strategic weapon systems and those nuclear, chemical, and biological weapons that they have. These are the folks that are actually helping the former Soviet Union saw airplanes in half and
:35:34 totally dismantle their weapons, et cetera.

The technology development directorate is the directorate which I personally am assigned under as a division. Our responsibility is to develop, test, and field those technologies to the war fighter. Our
:36:01 division, approximately 144 folks located at Kirtland

Public Scoping Transcripts 2003

Air Force Base, are responsible for the testing and field (indiscernible) to prove that those concepts are useful before they are transitioned to the war fighter, chemical and biological defense, protection against chemical and biological agents, protective masks, suits, giving the war fighter that capability so that they can survive in that environment.

And combat support, those are our emissaries, for lack of a better word, that keep in contact with the war fighters to make sure we understand what their requirements are and we can provide them the capability that they need in order to reduce that weapons of mass destruction threat.

In New Mexico, in order to show you pictorially how we carry out that mission, in the upper left is our ability to train first responders to appropriately handle any sort of nuclear weapons-related accident. We have the schoolhouse training facility at Kirtland Air Force Base in Albuquerque, and we can show that those first responders, if this ever were to happen, have been trained and equipped to do so.

The lower left shows the magnetic (indiscernible) area simulator. We are responsible for providing various simulator capabilities to duplicate

Public Scoping Transcripts 2003

:12:42 the effects of x-ray, gamma ration, the by-products of a high-altitude nuclear weapons detonation, to ensure that we can test missile components and satellite components so they can survive in outer space. We have :13:54 simulators that do that, primarily located at Kirtland Air Force Base.

Our consequence management advisory team are specially trained personnel which provide information and response capability in case there is a :14:15 domestic event involving chemical, biological, or radiological materials. They also are primary advisers to our combatant commanders overseas in order to ensure that we handle and address all the aspects of release of a chemical agent. Essentially, these folks come in :14:52 and advise both folks here in the United States and overseas on how best to reduce the contamination that may result from weapons of mass destruction.

Upper right is a photograph of one of our test beds, shows a precision-guided munition specially :15:11 built to penetrate a hardened and deeply buried structure, reinforced concrete, which could have weapons of mass destruction inside. We use these counterforce demonstrations to ensure that our weapons that we develop for this purpose can penetrate and can :17:12 get into the simulated weapons of mass destruction

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Public Scoping Transcripts 2003

:17:16 target, which would be inside of that.

And finally, in the lower right, what we're seeing now is the need to provide capabilities of detection in the event of a terrorist application of

:17:55 getting ahold of nuclear material or a nuclear device. A lot of times that's called a dirty bomb kind of scenario. In this particular case, we do research and development for detection capability and we train folks in how to use that and pass it on to Department of

:18:36 Transportation, et cetera, in order to detect that threat and to protect us from that threat.

Our programs in the New Mexico right now, besides those existing tests that we've been doing, are specially related to reducing the threat of weapons of

:18:57 mass destruction since approximately 1995. What we're looking at emerging within the next year or so is construction of a dedicated tunnel project at White Sands. It's called Capital Peak. We've invested $6 million to construct this tunnel complex. If you go to

:20:29 the next room over here, you probably have seen the diagrams showing what that tunnel complex looks like.

What this does is this creates a tunnel testing environment. What we've found is that the war fighters have come back and said that a lot of threat

:21:01 countries like to hide and conceal weapons of mass

Public Scoping Transcripts 2003

destruction in (indiscernible) of those specially designed concrete reinforced bunkers under the tunnels. So we are providing test (indiscernible) capability to ensure that we can accurately defeat that threat.

Related dollar contracts for envisioned tests that are going to come with the conclusion of this tunnel complex is to be completed in about another month or so, we estimate that we will be using this tunnel complex for related tests over 10 years and $100 million coming in to support those tests.

We have emerging technologies -- I call this quick reaction technologies -- that we are providing in order to ensure not only that we help design weapons that can penetrate these hardened, deeply buried structures, but also has properties embedded within the actual explosive (indiscernible) itself that can defeat any chemical or biological agent that's located inside. So we destroy it inside, don't release it on the outside. We perform those tests at White Sands, again, using simulators.

About the test frequency, a lot of people ask, well, how many tests do you do per year and what's the trend in the future? Right now, the number of scheduled tests in FY02, that's 1 October to the September time period in '02, was about 108 tests, and

Public Scoping Transcripts 2003

and that's at these three sites, Kirtland Air Force Base, White Sands Missile Range, and the Nevada Test Site. You can see that in this particular fiscal year, again, it ends 1 October, we have 120 scheduled. And we're foreseeing the test requirements will only increase because of the current world threat situation involving weapons of mass destruction.

And if you will ask me how many of those envisioned 120 tests will be conducted at Kirtland Air Force Base and White Sands, I would say probably well over half, maybe even three-quarters, based on when we get the specific requirements in, of those will probably be done at White Sands or at Kirtland.

And categories of tests that we would do, how to defeat hardened, deeply buried targets, antiterrorism force protection aspect, for example, the use of conventional explosives, a car bomb, against a building, we do tests at White Sands to help with that. In that particular case, the weapons of mass destruction isn't chemical or biological, it's an explosive, it's a car bomb. And finally, nuclear weapons effects simulation. I mentioned that that's an ongoing requirement that we provide using simulators.

Lethality and survivability testing. That's what our business is all about, again, to reduce

Public Scoping Transcripts 2003

the threat of weapons of mass destruction. And we do that by focusing on not only the technologies, developing the hardware and the software, but also the techniques. We train people on how to employ it. And these tests (indiscernible) against a wide variety of targets.

If you go to the left, I mentioned to you about, you know, the compound kind of tests for antiterrorism force protection. At White Sands, we have a target complex where we actually (indiscernible) and we use various types of explosives in terrorist venues. And through our instrumentation, we measure the effects, and we do give the information back to contractors so that they can build safety aspects into their building design and materials to a standard threat.

By the way, that was used at the Pentagon in the retrofit after the September 11 accident happened.

In the center, it shows one of our precision-guided munitions penetrating the heart of a deeply buried target. Again, two aspects we look for there, the ability to penetrate and the ability to go up inside to destroy the what would be weapons of mass destruction stored inside and not to have any

Public Scoping Transcripts 2003

:17:06 collateral effects release.

Our special forces, our prime user and customer of our technologies and capabilities. You can think of the capabilities they would need for special :17:17 force applications. It would have to be light, transportable -- they call them manportable -- so they can carry with them their application.

And on the far right, you see the B-52, the standard weapons (indiscernible) platform where we 18:34 put some of our weapons in order to (indiscernible) an element against a target.

We design test beds to meet specific purposes for tests to reduce the threat of weapons of mass destruction. For example, at White Sands we have 21:30 a large blast thermal simulator, which simulates the heat and blast effects that you would encounter in a nuclear weapons detonation. Why would we use that? In order to evaluate survivability against armored vehicles, for example, ship masts, that sort of thing.

43:12 This is done through conventional explosives. We try to duplicate the temperatures and the pressures that you would experience with that. It's done at the large blast thermal simulator site. The picture is at the lower right.

44:38 Additionally, we have a permanent high

Public Scoping Transcripts 2003

explosive test site where we specifically build test structures for individual test requirements, the large bore, high explosives, bombs, cruise missile tests against specific targets, hardened, nonhardened, that may include chemical or biological weapons, and we use simulants to simulate those materials that would be inside.

At the Capital Peak tunnel complex I mentioned briefly before, that will allow us to do a duty version test requirement using granite geology, and with that, it will give us capability to, again, see how well we can provide the war fighters the capability to defeat weapons of mass destruction in that granite tunnel environment.

Additionally, we are looking at a specific test bed environment which duplicates, basically, granite, so we do penetration tests in granite geology as opposed to having to use a full tunnel. That way, it's more cost-effective and we provide a safer environment for these kind of penetration tests.

Lower right shows one of the component test structures. I mentioned that we could duplicate any sort of building, use conventional explosive sources, see what the effects would be of the car bomb

Public Scoping Transcripts 2003

type attack against a building structure, and then we would provide that information back to building designers and material developers so they could develop safer material and building designs.

The launch test structure over here shows the inside. That's where we would see the ability to penetrate various test structures.

Where do we do our testing activity at White Sands? This map shows the location of the large blast thermal simulator on the left, that permanent high explosive test site I mentioned, the new Capital Peak tunnel complex will come in about, I estimate, 40, 50 miles south of that, and the granite phenomenology test beds are located fairly close to the Capital Peak tunnel complex.

Again, the Capital Peak tunnel complex should be completed within a month. The LBTS, large blast thermal simulator, current high explosive test site already exists and has been being used for tests for a few years now. And then the granite phenomenology test beds will be located fairly close and it will be approved for construction after this process.

Why would we want a programmatic EIS? Essentially, our current environmental assessment

Public Scoping Transcripts 2003

:07:29 process is one in which we get a test requirement and you have environmental assessment for that specific test bed. It's not a very cost-effective way to do business. By going with an umbrella approach, with the
:22:01 programmatic EIS, we can include the Capital Peak tunnel complex, those granite phenomenon test beds, and then use the programmatic EIS environmental impact statement approach for those existing test beds, as well. We think that's a much more cost-effective and
:23:33 will be a much safer way of ensuring that our tests be done the safest that we can do it.

Our current environmental assessment process moves the frequency of the chemical and biological warfare simulants. Again, our primary
:24:14 mission is to ensure that the war fighters have that capability and we have to simulate chemical and biological agents. We cannot use them. But we have to make sure that the simulants not only are safe, which they are when we use them, but that they do duplicate
:25:06 as much as the qualities of the actual chemical and biological agents so that when we provide the capability to the war fighter, it will work.

In the new weapons technologies, we saw the need for emerging technologies. And you may have
:25:25 read about them in the newspapers, the (indiscernible)

Public Scoping Transcripts 2003

27:38 weapons, et cetera, where instead of using the standard weapon that's been in the inventory, we're looking at new explosive fields for those weapons. And we want to make sure that we address any sort of environmental
38:01 aspect of testing using those particular fields, again, under this umbrella programmatic EIS.

And finally, we have limited space to do phenomenology penetration tests at a granite test site. We want to expand that to make sure we get full testing
39:19 capability to provide the required technology to the war fighters.

This programmatic environmental impact statement would support Defense Threat Reduction Agency and expansion of testing activities at White Sands
41:26 because what we want to do under this programmatic environmental impact statement would include the use of chemical, biological, and radiological simulants possibly in greater frequencies and quantities.

I told you about what we're seeing is a
42:08 trend in increasing test requirements. We want to make sure that we are encompassing that in an environmental review process; hence, the programmatic EIS approach.

We want to ensure we support the use of new weapon systems, such as cruise missiles and other
43:09 position weapons, not only at the Capital Peak tunnel

Public Scoping Transcripts 2003

:43:13 complex, but at that thermal high explosive test site. And finally, we want to ensure that we safely and economically do penetration phenomenology testing against various geologies, granite and limestone flat
:44:28 areas, which the White Sands area has, and so, therefore, we want to use that capability.

With the inclusion of the Capital Peak compound (indiscernible) and the increased area of the
:17:58 granite phenomenology test beds, the programmatic EIS will include broader geographical area coverage of White Sands where we do our testing. Additionally, we would include in this a requirement for continued operation and maintenance of our existing test
18:55 structures.

We will use test structures over and over again to ensure that it can be safely and economically for those weapons systems evaluation and also for construction of new test structures or enlarging the
20:44 test beds and developing new test beds in order to keep up with the emerging needs to support the war fighter to reduce the threat of weapons of mass destruction.

Testing operations and maintenance activities (indiscernible) targets, currently we do
21:43 that at the Nevada Test Site in Nevada. By getting

Public Scoping Transcripts 2003

capital (indiscernible) that will give us the capability of doing that here in New Mexico.

I talked to you about the use of increased quantities and expanded selection of simulants. We want to make sure that we are using the appropriate simulant to duplicate the weapons of mass destruction we're trying to defeat.

And finally, we want to make sure that our different test operations and support facilities are improved because of the increase in tests. We want to make sure that we have better facilities for our contractors and our work (indiscernible).

Now, what are the alternatives? One would be, okay, reduce the proposed test program, restrict the use of the simulants and the frequency of their use at the test sites, at each test bed, so, fewer simulants and less quantity. Conduct some tests at other ranges. And right now, we know that the White Sands Missile Range offers the ability to test various precision-guided munitions, to include cruise missiles, against these WMD targets, where other test locations don't offer that. This is because of airspace and just because of (indiscernible) there really isn't an action alternative.

We are sensitive to the potential

Public Scoping Transcripts 2003

concerns regarding the use of simulants. We need weapons of mass destruction simulants because actual chemical, biological, or radiological material release is restricted by law. These are highly toxic materials. That's why they are weapons of mass destruction. So, we rely on simulants which mimic the physical and chemical properties of actual warfare material.

We control by quantity and the frequency of use any sort of adverse effects that those simulants may have. And again, the potential effects of those simulants on the environment are (indiscernible) what we control as part of this programmatic environmental impact statement process. Again, our mission is safety is number one.

I've given you an overview of what from the operational and technical side the requirements are for testing. Mr. Mike Demko will now give you the actual process of how we will go about the programmatic environmental impact statement.

Can I ask now if they have any questions? Would that be okay, or do you want to wait till after Mr. Demko?

SHERRY: If they'd like to ask now, all that's fine.

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:00:14 COLONEL THOMAS: Otherwise, afterwards we'll be available for a question-and-answer period. So, if that's okay, then, Mike, why don't you come on up.

:00:31 MR. DEMKO: Good evening. My name is Mike Demko. Once again, I'm the chief of the environment safety and health branch for the Defense Threat Reduction Agency at Kirtland Air Force Base.

What Colonel Thomas said, he described :00:55 the proposed mission and requirements for the programmatic environmental impact statement. What I'd like to do now is go over the procedures that are required by the National Environmental Policy Act that we have to follow, emphasizing along the way the :01:17 environmental and safety concerns that will be addressed and the input that we would like to get from you, the public, in our assessment for this PEIS.

Can everybody hear me okay? Thank you.

The National Environmental Policy Act, or :01:59 NEPA, establishes the broad framework and guidelines that we, as an agency, must follow in the PEIS, or programmatic environmental impact statement, process. The objective is to help us, as an agency, make the right decisions, the informed decisions based on all :02:27 the potential environmental consequences that may

Public Scoping Transcripts 2003

result from our test programs that we would like to undertake, based on our mission, and take actions, like it says, to protect and restore and enhance the environment through the process.

Our role as the lead agency in our environment, or PEIS, is our programs that we are given or will receive a mission to conduct these tests. But we don't rely on just our own expertise or not even on your public comments. We look to other agencies, too. We look to the folks at White Sands Missile Range as a cooperative agency. We're not going to do this in the dark, blind. And we'll also invite other technical experts, such as the state regulators, to help us with this entire process.

Like I said, the PEIS is developed in accordance with the National Environmental Policy Act and the Council on Environmental Quality Regulations. They wrote the book. We have to follow their process. In a nutshell, it's a public document, so it requires public input.

The primary purpose is ensuring that the policies set forth in NEPA are followed and incorporated into our programs and actions that we take. In other words, the tests that we conduct have to be considered in this entire process of developing

Public Scoping Transcripts 2003

the PEIS.

It provides the public with full and fair discussion of the potential environmental impacts and opportunity to review and provide comments on the proposal. The bottom line: Here is our proposal. What do you think about it?

We solicit your comments, which I'll discuss in more detail as to how we want to go about getting those comments in this entire process.

It's a very lengthy process, from the notification of intent, which we published back in May, this past May, through the public scoping meeting, like we're having tonight, through the release of the first draft in sometime late winter or early next spring time frame, more public hearings once that's done, probably next summer, and then the comment period, and then publishing a final PEIS, typically takes about 12 to 24 months. There is a lot that goes into that, which I'll discuss right now.

What is it? It analyzes actions that are broad in scope. The PEIS process, as opposed to a regular just environmental impact statement, looks at a whole gamut of weapons, simulants, and programs to be used in the various tests areas at White Sands. It may be geographically spread out throughout the whole

Public Scoping Transcripts 2003

geographic region, in this case, White Sands.

Colonel Thomas had a map showing you where the various test beds are. You're welcome, after this briefing, if you haven't already seen it, we have several diagrams that show the locations of where these tests will take place and that will be included in the PEIS.

It creates a framework, analytical framework. We take the -- we take the data, the information from the experts and public comments and we (indiscernible) it on to other documents that we have. In other words, if we have -- if there is a current environmental assessment that we test under, we use that and not start from scratch. We use that data we receive and incorporate it into what we're developing, the draft of the PEIS.

Very comprehensive, like I said. This is from the cover sheet to the environmental consequences that are being considered, this is what's made up. The final document will include all these items here. And of course, the distribution list for the personnel that we need to send a copy of it to.

And we don't -- the PEIS doesn't just look at the typical water, air, and soil contamination that could occur as a result of these tests.

Public Scoping Transcripts 2003

11:01 Everything from cultural and historic resources to the soil geology to (indiscernible) resources to support the local economy that could have an impact. All of these items are included within the PEIS.

12:01 Okay. I said that the notice of intent for the DTRA's PEIS started, it's published in the Federal Register in May, this past May, and these public scoping meetings will take place here, and the next two nights we go up to -- we go up to Alamogordo 12:57 and Socorro the next couple of nights. And then once that's completed, we'll begin the preparation process for the draft of the PEIS. The plan in this time frame here evolved through the spring of 2004, and those are our best guess for the dates, too. Those aren't 13:21 hard-and-fast dates.

The next step will be filing the draft, once it's compiled, with the Environmental Protection Agency and publishing a notice of availability in the Federal Register, planned for next summer, followed by 13:39 another set of public meetings, public scoping meetings like we're having tonight, and, once that's done, a 45-day comment period, where we take comments from the folks that do go to the other scoping meetings, incorporate those, analyze them, incorporate those into 13:59 our final product, our final PEIS.

Public Scoping Transcripts 2003

14:09 Preparing the final (indiscernible) depending on the public comments and the other information we receive, sometime late next summer. It could go into next springtime. Like I said, it's a
14:56 pretty lengthy process. Filing the final PEIS, then, with the EPA, Environmental Protection Agency, and posting notice of availability in the Federal Register, planned for spring of 2005.

Then, waiting 30 days afterwards to post
15:17 a notice of availability. And then to publish the final record and the record of decision and to record it formally before action is -- before any type of test can actually be conducted (indiscernible) under the PEIS.

16:45 Public involvement. I've mentioned that a couple times now. We solicit your input throughout this whole process. Your comments that you fill out either in this session -- that's one reason why we're taping it, to get your comments -- or if you fill out a
17:03 public comment sheet that's available outside on the tables, we take those comments and identify, for instance, if you bring up, well, did you look at this particular item, or I'd like for this to be addressed in the draft, we'll look at those things and identify
17:22 your concerns and examine any type of range

Public Scoping Transcripts 2003

17:29 alternatives.

We don't have all the solutions. So, if you propose something, we also solicit your comments, input. In other words, if you do it this way, this may 17:42 work out better than doing it that way. Okay? So we solicit both types of comments, and we'll analyze both types. It will help us address the impact and also identify any needs to mitigate hazards that we hadn't thought about ourselves.

:18:11 Comments are allowed anytime throughout the scoping period and up to -- in this series of public scoping meetings, up to the 15th of September. We'll categorize them and analyze them. On the issue of priority, if we get comments such as an action that :18:33 we hadn't thought about or something to consider, we'll put that at the top, one of the tops of the lists.

It just depends on the comments that we're receiving. Sources of information and issues to be addressed and evaluate, those are all ways that :18:51 we'll categorize the comments. And we'll consider all comments provided as we're analyzing and preparing the draft of the PEIS.

Oral comments spoken during these public meetings, like I said, that's why we're videotaping to :19:09 make sure we get it right, that we don't just

Public Scoping Transcripts 2003

19:12 paraphrase one of your comments.

Written comments, I've already mentioned, they will be provided to us tonight, or you can fax them, mail them, or e-mail them, and if you received a 20:46 copy of the handout of the briefing slides, it gives all of the addresses on it, so you might want to take notes.

Now, the comments, this is our office in Albuquerque, this is our fax number, or you can e-mail 21:02 it. We're really high-tech at the DTRA.

And we have a public web site that you can view, and if you're already used to looking at the web site for White Sands Missile Range, it does have a link. The link is to the Defense Threat Reduction 21:24 Agency web site that you see up here. Of course, there is our phone number for the public affairs office, Sherry and crew.

Okay. Your copy of the future draft of the PEIS, once it is out on the street, like I said, 21:46 fill out your comment sheet. It has on the bottom, it has, do you want to receive a hard copy, a paper copy, e-mail us a request, or view it at certain libraries? There is a handout that says which libraries it will be posted at once it's out on the street. Or you can 22:10 download it if you have a computer at home or at your

Public Scoping Transcripts 2003

office.

We encourage you, of course, to make comments and be part of the process that we have. That's why -- that's why it's established under that National Environmental Policy Act.

Thank you. Sherry.

SHERRY: What we have planned for the rest of the evening is to have a question-and-answer and comment period. If you have any questions that you'd like to ask right now of our experts, we'll be happy to answer them.

And at this time, I'd like to ask Colonel Thomas and Mr. Demko to come up and sit at the table and answer any questions you've got. If you have any, please just feel free to ask any, or if you have any comments. And if you don't, that's fine.

UNIDENTIFIED SPEAKER: I have a question. Is the -- is responsible -- certainly it's clear that your main responsibility is to protect our environment. That's fine. But when testing, what agency is responsible for the evaluation of the quality of the test?

To give you an idea, the thought I'm working is you've gone to great lengths to protect the environment by using simulants. But what if we come up

Public Scoping Transcripts 2003

with a weapon that doesn't work? I mean, I can understand, it seems to me -- and maybe I have the wrong idea -- that we're entirely talking about an impact statement without looking or evaluating the effectiveness of the test that you're running in the first place.

That is, I'm trying to say we're dealing with a thing that looks to me at cross-purposes. A weapon of mass destruction certainly needs to be protected against. It is one of the worst environmental weapons we can have. But in using your simulants, who is responsible to see that the weapon -- although it might get the simulants, great -- but how do we know we get the real thing, the anthrax, the stuff that can get spread all over in an explosion?

Those are the things that are worrying me. I'm not enough of an expert to really -- it's just troubling to me, okay?

COLONEL THOMAS: Yes, sir. If I may answer that -- can everybody hear me? The way that the Defense Threat Reduction Agency gets test requirements is directly from the combatant commanders, and in the United States -- you mentioned that anthrax scenario -- through the combatant command that was responsible for the Northern Command. That Northern Command commander

Public Scoping Transcripts 2003

is also tied in with the new Department of Homeland Security. We get the test requirements in. We then use our technical expertise to design a test bed that can appropriately test our threat reduction technologies against that specific threat.

You mentioned about chemical agents. The basic chemistry of many of the chemical agents that are being used today are basically those that existed back in World War II and World War I, minor chemical derivations of chemical compounds that exist.

So right now, we're able to set up appropriate test beds and measurements capability against chemical and many biological agents because those haven't changed very much over the years.

There are some new and emerging threats that are coming out, boutique-like biological agents, et cetera. But our job is to take the requirements and design a test bed environment to include a selection of environmentally safe and approved simulant, have it cleared through the environmental process, conduct the test, collect the data on its effectiveness to destroy that simulant, and then provide that back to the war fighter so that they can use that in procuring weapons systems using that technology.

Sir, that was a complicated answer to

Public Scoping Transcripts 2003

50:27 your question, but I hope it helped address some --

UNIDENTIFIED SPEAKER: Well, I asked a complicated question.

COLONEL THOMAS: So I hope that that will

51:12 give you some information.

UNIDENTIFIED SPEAKER: That helps. It still is not clear to me that you know that -- I don't -- it's not clear to me who does the evaluation. I can see where we're leaning over backwards to keep

51:30 from harming our environment.

COLONEL THOMAS: Yes, sir.

UNIDENTIFIED SPEAKER: And it's the purpose of the enemy that we're trying to defeat is to harm our environment to such an extent. And to me,

51:44 it's kind of a two-edged sword.

COLONEL THOMAS: Yes, sir, it is.

UNIDENTIFIED SPEAKER: I'm just saying let's not lean over backwards to protect our environment to such a point that we come up with an

51:59 ineffective weapon. I guess you've answered that the best you can. I don't understand it thoroughly, and I'm not in a position to influence it anyway, so just curiosity.

COLONEL THOMAS: All right, sir.

52:18 UNIDENTIFIED SPEAKER: In your briefing

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you talked about the cruise missile and other precision weapons.

COLONEL THOMAS: Yes, sir.

UNIDENTIFIED SPEAKER: Would those other precision weapons include the Predator, where you would have to address the airspace? **See Sections 3.5 and 4.5**

COLONEL THOMAS: With any use of air-delivered precision-guided munition, or in the case of a Predator, that's an unmanned (indiscernible) vehicle, what's very important for safe operations in a testing environment is to control the airspace where either those cruise missiles or those precision-guided munitions or that Predator would operate.

We want to make sure that there is no chance whatsoever of an air-to-air collision. We want to make sure that our range control capabilities for tracking and monitoring reference particular resources are the state of the art.

UNIDENTIFIED SPEAKER: So the EIS would include the airspace? **See Sections 3.5 and 4.5**

COLONEL THOMAS: Yes, it would. Part of that is to -- just to take a look at the air quality. But maybe not in a programmatic EIS as far as for airspace, but in the partnering with White Sands, to ensure that we have range control and airspace

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57:40 maintenance in place, which they are right now currently.

So that would not, perhaps, simply fall under an environmental concern addressed under the
57:51 programmatic EIS, but it is addressed in the process of scheduling and actually setting up a test environment, which would include those kind of resources, cruise missiles, prevision guided munitions, and unmanned (indiscernible) vehicles.

58:43 Does that answer your question, sir?

UNIDENTIFIED SPEAKER: Yes.

UNIDENTIFIED SPEAKER: You stated that the NEPA establishes a framework protecting the environment. And my question is, what agency will be
59:14 responsible to ensure that these guidelines are complied with, and how will this be -- how will compliance be determined? Will there be a series of inspections and that's it? Somebody overlook the simulants and determine, yeah, this is safe to use?

See Appendix A and Section 1.1

59:37 MR. DEMKO: Sir, one of the coordination actions that my office and the test directorate, test division will have is coordination with the various state regulators in New Mexico, who provide the oversight, whether it's a federal agency or a state
59:58 agency. So as far as who will actually oversee, make

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sure that the stipulations in the EIS are approved and are followed correctly, they provide that type of oversight, state agencies.

And, Bill, do you have anything else to add to that? It would be the state regulator, sir, the state environmental.

UNIDENTIFIED SPEAKER: The state regulators, will they go back and review your work and determine if you are in compliance with what you said you were going to do in the EIS? **See Appendix B**

MR. DEMKO: Yes, it will.

UNIDENTIFIED SPEAKER: The White Sands Missile Range environmental office will also be the first line of review, and then above that will be state where the state has authority, and then some federal agencies where they have authority.

MR. DEMKO: And that's why we're routing this through -- we're not routing -- but we'll be coordinating this with the White Sands environmental safety office and be having meetings with the state regulators while we're developing this, that we make sure that we do it the right way the first time, and that we don't violate, of course, any particular state regulation, which even though we're a federal agency, we still have to go under.

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Did I answer your question, sir?

UNIDENTIFIED SPEAKER: You wouldn't be immune from penalties if you don't follow the rules?

MR. DEMKO: The Environmental Protective Agency can penalize federal agencies. They can -- I believe they can even reach down and touch individual people, too, if they mess up. Yes, sir. Big bucks, too.

UNIDENTIFIED SPEAKER: I'd just like to make a comment, that you mentioned one of the alternatives, you mentioned that White Sands was the only place that had the airspace, and there is just a whole list of other things that White Sands has that is nowhere else. Everybody says, "Never worry. White Sands is never going to go away. It's always going to be a going thing."

But there is always pressures. And I would like to see more in your statement, even though it's maybe not a part of your statement, as such, that would support White Sands as being the only place that you could do this type of stuff, and to try to do it somewhere else would be, if you could even do it, would be just a humongous expense. So that was just a comment. See Section 2.4

UNIDENTIFIED SPEAKER: I have a comment,

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:03:46 but probably I will be the only person in the room that feels this way. Why are you giving this to the public? I know we have the Freedom of Information Act and all this, but you're allowing, with all these public
:04:00 forums, to allow the enemy to get somebody in one of these positions to infiltrate to mess up your results. Why didn't you just do it? **See Section 1.6**

MR. DEMKO: Well, ma'am, I'll try to answer. Part of it is the requirement, legal
:04:23 requirement that we do it under the National Environmental Policy Act. It says you will do it and you will do it this way. You will have these public scoping meetings, even though it's presenting things that we do, that we may not normally tell people about
:04:42 unless they visit our web site.

But NEPA is the one that actually requires us to do it, okay, plus it's being good stewards of the land, too. It may sound corny, but it's being good stewards of the land, trying to
:05:05 accomplish our mission to protect public safety, not just the -- from our tests, but also national security type public safety.

UNIDENTIFIED SPEAKER: To add to that, I mean, anybody with any capability of having any common
:05:24 sense knows that White Sands Missile Range can never go

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05:27 back to the public. There is too much stuff buried out there. There is too much stuff that's been spilled out there. I mean, anybody that's been involved with anyone who has worked in White Sands, that's common
05:38 sense. See Sections 3.9, 3.10, 4.9, and 4.10

I appreciate what you're doing. But I like the atomic bomb just going off and we all go, whoa. So I'll shut up.

COLONEL THOMAS: I can assure you that
05:52 the Defense Threat Reduction Agency's number one concern is to accomplish these vital tests safely, and that includes protecting our forces who are actually doing the tests and also ensuring that (indiscernible) environment is safe.

07:57 I can also assure you that the actual access control policies and the way that we control information related to test bed design, test execution, and test data analysis is strictly controlled to be sure it doesn't get into any other than appropriate
08:35 (indiscernible) hands.

UNIDENTIFIED SPEAKER: I hope so.

COLONEL THOMAS: So, we ensure that the aspects of scheduling, being tested, executing the tests, is done with the strictest controls of the
09:39 overall information.

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UNIDENTIFIED SPEAKER: A few of us lawyers would want to...

COLONEL THOMAS: Well, we want to make sure that we are open and honest about all the aspects of the environmental and safety related, and so we have those responsibilities (indiscernible) --

SHERRY: I feel like I'm in church. If there are no other questions or comments, we appreciate your interest and your taking time out of your busy lives to come here tonight. If you think of something as we're closing up, please feel free to talk to any of our experts that are here tonight.

Don't forget to make some -- if you have any comments, that the public comment period goes through the 15th of September if you postmark your comments by then or you submit them in an e-mail by that time. You have the comment sheets out in the hallway. You can the take them home with you. You can fill one out tonight, if you'd like, we'll wait, and submit them at this time.

COLONEL THOMAS: If I may, I'll be in the next room, over there by the posters, so if you have any questions, if you walk by there and something comes up, I'll be available.

SHERRY: We're here till 9:00 if you have

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anything afterward that you haven't gotten a chance to say before.

UNIDENTIFIED SPEAKER: I'll just ask the question. Exotic materials, will the EIS identify any new exotic materials that will be used in the weapon that is used to defeat the -- I guess it will. Is that right? **See Appendices E, F, G and H**

COLONEL THOMAS: In the testing business, we may get a last-minute test requirement from a service, for example, to test a new and innovative explosive material. Under the current process, we use environmental assessments to take that requirement in, to work with the environmental staffs at White Sands Missile Range and from the Defense Threat Reduction Agency in order to set a safe environmental environment to ensure that we can do this test appropriately and safely.

Under the programmatic EIS, the intent is to broaden it to try to include what we see are emerging technologies. But I think you're absolutely right. We can't nail all of those down. We simply do not know.

UNIDENTIFIED SPEAKER: So you'll go -- it will be a living process, if you discover that?

COLONEL THOMAS: Yes, sir.

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14:49 UNIDENTIFIED SPEAKER: Then you'll modify or do whatever is required.

UNIDENTIFIED SPEAKER: Modify or provide an environmental assessment.

15:16 COLONEL THOMAS: It would be a supplement to that living document, so it will cover those new and emerging materials.

UNIDENTIFIED SPEAKER: Thank you very much.

15:32 (End of formal meeting.)

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Transcription of Videotape PEIS Briefing, 13 August 2003 Socorro, New Mexico

TRANSCRIPTION OF VIDEOTAPE

PEIS BRIEFING, 13 AUG 03

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:54:29 SHERRY: I'm Sherry (indiscernible) from
the Defense Threat Reduction Agency public affairs.
And let me just give you a brief introduction and
introduce you to some of our speakers and some of our
:54:40 subject matter experts who are here. I think many of
you have met already.

Our main speakers tonight will be Colonel
Chuck Thomas. He is the chief of our task and
technology support division from the technology
:55:14 development directorate, the Defense Threat Reduction
Agency. And Mr. Mike Demko here, and he is our chief
environment safety and health branch Albuquerque, of
the acquisition and logistics directorate.

We also have Lieutenant Colonel Tom Van
:55:54 Alsteen. He is an environmental engineer from the
Defense Threat Reduction Agency. And we have Lindy
Ford here. He is a range engineer from White Sands
Missile Range.

And Russ Cook is here from White Sands
:56:10 Missile Range. He is an environmental scientist. We
also have public affairs officers from White Sands,
Mr. Larry Thoreau and Ms. Debbie Bingham.

This is being videotaped tonight for an
official record of the public scoping meeting. We also
:56:33 have seated someone who can translate into Spanish

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57:04 (indiscernible) he is actually a chief information specialist and archeologist and he is here (indiscernible).

These are the locations of the public 57:40 scoping meetings. We had one last night in Las Cruces, this one tonight in Socorro, and one tomorrow night on the same schedule in Alamogordo.

And this is basically the purpose of the meeting. One thing we'd like to be sure and do is to 58:09 get public comments here. And, also, to let you know if you have comments, there is a sign-up sheet as you come in to register, if you'd like, or you can send (indiscernible) comments.

What we'll like to do is if you do have a 59:03 formal statement to make, that you limit it to ten minutes so that others can speak.

Colonel Thomas.

COLONEL THOMAS: I'm Chuck Thomas, and as Sherry mentioned, I am chief of the task and technology 59:54 support division of the Defense Threat Reduction Agency. And what I'd like to cover tonight are the technical aspects of the tests at White Sands Missile Range.

But first, one of the questions that I'm 00:15 often asked is what is the Defense Threat Reduction

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Agency? What do you folks do?

The Defense Threat Reduction Agency has a very simple mission and that is to make the world safer by reducing the threat of weapons of mass destruction. And we are a combat support agency, which means that our primary responsibility is to provide capability to the war fighters and what used to be called CinCs. They are combatant commanders, which are overseas, and we also have one or more commanders responsible for the United States. So it's our mission to provide this capability to reduce the threat of weapons of mass destruction to these war fighters.

Now, the agency is comprised of approximately 2,000 people, about 50 percent military and from all services and 50 percent civilian. And we have an annual budget of $2 billion, approximately. That's looking at fiscal year '03, which begins 1 October and ends the end of September. And about $50 million of that is dedicated for Defense Threat Reduction Agency activities here in New Mexico.

We are the interface providing research and development capability to the war fighters for things or aspects related to reducing the threat of weapons of mass destruction. And particularly, when looking at September 11, if you look at before

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:09:45 September 11 and the attacks on the World Trade Towers, the agency, the Defense Threat Reduction Agency has established a niche as the go-to agency to provide the war fighters this capability, and particularly in
:10:17 Afghanistan and in Iraq.

The way we provide this capability as an agency is through these five functional areas. First, under arms control, the Defense Threat Reduction Agency has a team of specially trained and available
:10:54 inspectors, and their primary mission is to ensure that they inspect various countries who are signatories to treaties related to weapons of mass destruction: Chemical Weapons Convention, Biological Weapons Convention, Urban Skies Treaty, to ensure that those
:11:36 threats do not cross national borders and come into the United States.

Those are our inspectors who are out making sure that we identify, based on our international treaties that we've signed with the
:11:48 United States, and make sure those threats are not (indiscernible) United States' international borders.

Threat reduction. For the former Soviet Union, we provide technical expertise to assist the former Soviet Union countries in dismantling their
:12:29 weapons of mass destruction, destroying their chemical

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12:32 and biological weapons, destroying their delivery platforms, missiles, aircraft. We provide them the capability to do that.

In technology development, that's the
13:01 directorate which I am assigned under, and we develop tests (indiscernible) offensive and defensive capabilities and to provide to the war fighter in order to reduce the weapons of mass destruction.

We have the chemical and biological
14:27 defense directorate, whose primary emphasis is to provide troops deployed overseas in a hazardous environment, and related to weapons of mass destruction, protective and detection capabilities, protective suits, masks, and detectors against chemical
14:48 and biological agents.

And finally, combat support directorate. We provide capabilities to the war fighters, and that capability is to reduce the threat of weapons of mass destruction as relayed to us as an agency through our
15:22 combat support directorate, to assist those combatant commanders in assessing vulnerabilities related to weapons of mass destruction, and also assuring that we can (indiscernible) return and finance our nuclear weapons stockpile today.

18:05 So we essentially use the combat support

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18:07 directorate in reducing the threat of weapons of mass destruction as the go-between between those combatant commanders and us, the technology development directorate, providing the capability to reduce the threat of weapons of mass destruction. We have liaison officers that are assigned to those combatant commander staffs.

This shows the mission activities that the Defense Threat Reduction Agency conducts in New Mexico. In the upper left, nuclear weapons accident response training program out of Kirtland Air Force Base. That's the program in which we train first responders to detect and to mediate the effects, in case it would ever happen, of a nuclear weapons accident.

In the lower left, one of our mission capabilities is to provide the war fighters a simulator which replicates the effects of either a high-altitude nuclear weapons burst or the harmful effects of the sun for our satellites and our systems which are deployed in space.

Consequence management advisory teams are specially trained teams which provide modeling and prediction capability to war fighters in order to predict the hazardous effects of weapons of mass

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destruction.

In the upper right is a picture of the counterforce demonstration, which shows a precision-guided munition being used to penetrate a simulated hardened, deeply buried target, which may contain weapons of mass destruction. Our testing focus in this area is to ensure that we are providing the war fighter the capability and weapons to accurately penetrate a hardened or deeply buried target and to destroy the particular weapons of mass destruction asset the adversary may have inside.

In the lower right you're seeing an emerging capability for terrorists who use unconventional nuclear warfare, which is often referred to as a dirty bomb kind of context, where we have a scenario where terrorists could use radiological material. We have ongoing efforts at Kirtland Air Force Base to provide the capability to detect this material and to mediate the effects of the terrorists' use of unconventional nuclear material.

Our successes at White Sands testing applications really are numerous. The first bullet shows what we are currently constructing at White Sands Missile Range, which is a tunnel project and is part of our efforts to provide the war fighter capability to

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:26:26 defeat weapons of mass destruction which may be hidden in a hardened, deeply buried target.

One of the hardened, deeply buried targets can be a tunnel, so we are constructing a :27:24 $6 million complex at Capital Peak at White Sands Missile Range. And this tunnel complex itself, when completed, in approximately a month or so, we project that we will have a series of test requirements come in meeting that test bed capability. And we believe the :28:45 value of contracts associated with the Capital Peak tunnel complex (indiscernible) about $100 million over a 10-year period of time when we'll be using this tunnel complex for testing.

We also have a prompt agent defeat :42:49 program, CrashPAD. This is an illustration of a capability that we provided, in this case, not only providing the war fighter the capability of a weapon to defeat a hardened, deeply buried target, but in this particular situation, a new way to defeat biological :46:13 agents that may be contained within by using destructive properties, primarily heat and pressure, that are within that weapon itself. And this was tested at the White Sands Missile Range.

If you were to ask how many tests do we :46:34 conduct annually and where do we conduct those tests,

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46:39 if we take a look at what we conducted in fiscal year '02, our tests ranged about 108 tests in that fiscal year. This year, currently, we have 120 tests scheduled. And you'll see those test requirements are 47:16 only increasing. We did these tests in three primary locations, Kirtland Air Force Base, White Sands Missile Range, and the Nevada Test Site.

Those tests are primarily focused on these three mission areas, the ability to defeat 47:52 hardened, deeply buried targets, antiterrorism force protection scenarios, and nuclear weapons effects simulation, like we mentioned earlier.

Weapons lethality and survivability testing at White Sands is focused primarily to provide 48:45 and develop technologies and techniques to defend against weapons of mass destruction, including terrorism.

If I were to go through the pictures over here, the lower left shows one of our test sites, which 49:30 is essentially a building structure in which we can duplicate various types of building construction and actually construct the building using those materials and types, and then in a terrorist application, you would use conventional explosives and see what the 49:50 effects of various amounts of those conventional

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explosives would be against those various building materials.

We then provide the information back to contractors and designers so that we can pass on technologies on how they can better build or design buildings or the materials used in order to withstand this sort of terrorist attack scenario.

During September 11, the damage that was inflicted on the Pentagon, the results of this testing was used as part of the Pentagon's redesign program that was in effect, and the actual portion of the Pentagon that was hit by the aircraft on September 11 had undergone a retrofit, which included many of the technologies that we passed on to make that building more safe against that particular type of attack, this terrorist attack, and that included reinforcing structural members, wrapping them in Teflon, a lot of technologies that we provided. And after the attack had come, it really did reduce the amount of damage that happened and reduced the loss of life.

The next picture shows what our test and technologies would be in defeating a hardened, deeply buried target. Essentially, in this case you'd have precision-guided munition being delivered by an aircraft, an airborne platform, or a cruise missile

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that would penetrate an underground facility that may contain weapons of mass destruction.

The third picture shows another customer which we provide technologies and techniques to, and that's our special operations forces. The requirements that those individuals have, primarily to provide new technologies to reduce the threat of weapons of mass destruction, they have light and what they call manportable. They are carried in rucksacks by these special operations forces.

And finally, on the far right shows the existing B-52, and we provide capability to, in this case, the Air Force in how we can use existing weapons platforms like this to deliver existing weapons to, again, reduce the threat of weapons of mass destruction.

Our tests are conducted against a wide variety of targets, tunnels, hardened and soft structures, and inside of these structures we have a simulated biological and chemical weapons production facility in order to duplicate what that problem would be. And these tests really evaluate the lethality of current weapons that are in the inventory and new weapons that may be needed based on the emerging threat.

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Our test bed locations and test bed design are specifically developed and constructed to meet specific purposes. In the lower right-hand corner you see the large blast thermal simulator. This was a simulator that was constructed and is being used to duplicate the heat and pressure effects from a nuclear weapons detonation. And we do that by using compressed nitrogen, we super heat it, and then we release that down a large tube to duplicate the pressures that we would experience in that environment.

How would this be used? For example, Army tanks and vehicles, this would be a testing criteria of how we would assure that those vehicles could withstand pressure, particularly in this environment.

Additionally, at our thermal high explosive test site we have numerous test beds to accommodate (indiscernible) high explosives, conventional bombs, cruise missiles tests against a variety of targets and use of chemical and biological warfare simulants (indiscernible).

I mentioned briefly about the Capital Peak tunnel complex. Why are we building this? Because the war fighters have expressed a desire and need for a test bed capability for testing of weapons

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:59:07 and (indiscernible) in a granite tunnel environment as in the unique geology in White Sands.

Additionally, there are two flat (indiscernible) sites for phenomenology testing. There
:00:06 are photographs out in the foyer there which show this. Essentially, we can use granite by scraping a good deal of the soil off, exposing the granite, and do tests there in order to show the ability of the weapon to penetrate granite. That's what we use those
:00:26 phenomenology test beds for.

The lower left shows the large test structure and an internal view of what we would build. The lower right shows that building complex I mentioned to you earlier, where essentially we have structural
:01:07 members up, and then in order to duplicate various construction materials and techniques, we essentially (indiscernible) and then for (indiscernible) and force protection tests, we would use various amounts of conventional explosives (indiscernible) on the outside,
:18:27 like what would simulate a car bomb or a truck bomb, and we could measure the effects and pass on techniques on how to make these buildings more structurally intact and survivable (indiscernible).

Where are these test sites located at
:19:08 White Sands? The large blast thermal simulator is

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located where the arrow shows, the north portion, very close to (indiscernible) our heights test site. Our Capital Peak tunnel complex that we -- if we construct it, is approximately 45 miles south of that and fairly close to the granite phenomenology test beds that we have shown here. So those are our Defense Threat Reduction Agency test bed locations we currently use at White Sands.

Why are we going with a programmatic environmental impact statement? Right now our environmental assessments limit what we can do to provide this testing capability to the war fighters. And our environmental assessments, for example, looking at Capital Peak, before we even constructed that, we have an environmental assessment in place for the first planned series of tests.

That environmental assessment limits our testing to the use of conventional bombs only. So if we were to need to expand that right now to, let's say, cruise missile applications, not only conventional bombs, we would need to have another environmental assessment plan. In the programmatic EIS we would (indiscernible) that.

Our current environmental assessment limits to preconceived or chemical and biological

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warfare simulant use at our current high explosive test site locations, and under our existing environmental assessment doesn't take into account forecasting of new weapons technologies that are emerging and coming down as far as testing requirements for us.

I mentioned briefly about our existing (indiscernible) capability to granite phenomenology tests. The programmatic environmental impact statement will also support proposed expansion of testing and (indiscernible) activities at White Sands. It would support the use of chemical, biological, and radiological simulants with greater frequency and quantities than are currently approved under the existing environmental assessments, and it would support the use of new weapons systems, such as cruise missiles or other precision weapons, at all of our test sites, including the high explosive test site area and also the Capital Peak tunnel complex.

And the proposed expansion also includes the addition of the underground limestone flat areas for blast penetration and phenomenology testing. It will give us broader geographical area coverage and allow us to continue the operations and maintenance of our existing test structures that we use as targets for weapons system evaluation. It will allow us,

Public Scoping Transcripts 2003

43:51 additionally, to proceed with construction on new test structures or enlargement of our existing test rigs or development of new test rigs.

With the construction of the Capital Peak
48:58 tunnel complex, since we will reuse that, we will reuse that tunnel complex. It's like a similar tunnel-related target complex that we have at Nevada, where we require an operations and maintenance activity contract. We reuse it, so after each test, we go in,
50:15 essentially make it safe, clean it out, and get it ready for the next series of tests.

I mentioned earlier about (indiscernible) expanded selection of simulants, and our administrative support capability at the high explosive test site, we
51:13 would make sure that we would make that a little better to live in for our operators who are there in the planning and execution of the tests. We will be replacing older scale trailers with better boarding quarters.

52:04 What are the alternatives to the programmatic EIS approach? Would be to reduce the use of simulants and/or use alternate testing locations. We would do this by reducing the proposed test program, by either restricting the use of simulants or the
53:30 frequency, number, of tests at each test bed location.

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53:38 We could conduct those tests, also, at other ranges.

However, the White Sands Missile Range offers a lot of unique capability. One of them particularly is the ability to test cruise missile

53:52 operations against weapons of mass destruction targets, airspace, for short. And the granite that exists at White Sands makes it a very test (indiscernible) location for cruise missile use and testing. And there really isn't any actionable alternative

55:49 (indiscernible).

DTRA's number one priority is safety, and we are sensitive to potential concerns regarding the use of simulants in providing this (indiscernible) to the war fighter. Why will we need weapons of mass

4:52 destruction simulants? Actual chemical, biological and radiological material use and release is restricted by law. We can't use the actual materials (indiscernible) materials.

The simulant characteristics mimic

7:46 physical and chemical properties of the actual weapons of mass destruction warfare material. So we can use the simulants to provide an appropriate database back to the war fighter on the effectiveness and the capability of -- the capabilities that we are providing

8:04 them to reduce the threat of these weapons of mass

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38:07 destruction. And the potential effects on the environment are evaluated and controlled as part of this programmatic environmental impact statement.

What I'd like to do now is to introduce

38:46 Mr. Mike Demko. He is going to be explaining the actual programmatic environmental impact statement process and how this process is going to occur to support these testing requirements.

MR. DEMKO: Good evening. My name is

39:29 Mike Demko. I'm the chief of the environment, safety, and health branch in Albuquerque for the Defense Threat Reduction Agency. The programmatic environmental impact statement that the Defense Threat Reduction Agency will draft up follows the very strict guidelines

39:55 established by the National Environmental Policy Act, which established the framework and the ground rules for what all has to be in the PEIS, programmatic environmental impact statement.

The objective of the process is to help

40:46 those officials like DTRA make decisions, informed decisions, based on our understanding of the consequences of the types of tests that we foresee, like Colonel Thomas mentioned earlier, projected tests, concurrent tests, on the environment, and to take

41:38 action to protect, restore, and enhance the environment

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by identifying those in the PEIS.

Our role as a proponent for this PEIS is the lead agency. We're the ones that will draft it up. We're the ones that will work with other agencies, like the Army agencies at White Sands Missile Range, the state regulators of New Mexico, and other government agencies and technical expertise that we draw on. We won't do this in a vacuum. We will take these and consult with the experts.

The PEIS is developed in accordance with NEPA, the National Environmental Policy Act, the Council on Environmental Quality Regulations. It's a public document, as I will explain in the next few slides, like we're having this public scoping meeting. This whole thing is public and is open to the public, and it ensures that the policies and objectives, as spelled out in NEPA, are incorporated into the program and incorporated into the (indiscernible).

The process, like I said, (indiscernible) fair and full discussion of other potential impacts, environmental impacts.

This is quite a lengthy process between the notice of intent, which in this case we published last May, this past May, to these public scoping meetings to the release of the draft, public hearings,

Public Scoping Transcripts 2003

and the final PEIS and the record decision takes typically between 12 to 14 months. I'll go through each one of these in subsequent slides.

What is a PEIS? It analyzes the actions that we will take, it is broad in scope, it occurs in phases, and it will be dispersed geographically -- in this case it will be from the test facilities and the test beds in the northern portion of White Sands -- and it creates a comprehensive analytical framework that supports other actions, other analyses. We currently have an environmental assessment that we will tier and use the material in that as part of the PEIS.

Now, every document, every government document, there is a cover sheet, there is a strict format that's spelled out by NEPA that we have to follow. It includes all these various areas that we have to address in detail.

Now, the PEIS will also address areas that are not typical -- in addition to the typical things that people think of when they think of environmental protection. In addition to protecting water, air, and land, it will also address things like are there any cultural or historic things within the facilities in the area? What type of water resources are there? What type of effect will it have, could it

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have on public utilities, and socioeconomic resources that are in the area?

The development begins with conducting public comments, beginning with, like I said, the notice of intent that was published this past May to these scoping meetings -- we had one last night in Las Cruces, tonight is in Socorro, tomorrow night in Alamogordo -- preparing the draft PEIS, within this time frame, fall, to September next year, 2004, and filing a draft with the Environmental Protection Agency and posting the notice of availability in the Federal Register planned for this same time frame. Afterwards, conducting another series of public scoping meetings similar to what we're having now and, following those, allowing a 45-day public comment period.

Preparing a draft EIS following the public -- 45-day public comment period, planned for September through spring 2005. As you can see, all of the areas that we will be -- that we have to address, it is a quite lengthy process. And then at the bottom, filing the final PEIS with the Environmental Protective Agency, publishing a notice of availability in the public literature, planned for the spring of 2005.

Once that happens, we'll have to wait 30 days after posting that notice of availability, and

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then the final document will be recorded as a record decision and then published as a news release and then proceed (indiscernible).

As you can see, it's a quite lengthy process. That's why it may take up to 24 months to accomplish the whole process.

Public involvement. The National Environmental Policy Act requires that we have these meetings, plus we need to have (indiscernible) to solicit your public comments. The comments we receive will help us identify impacts, public concerns. That's what we're mainly concerned about. What concerns do you have? What areas haven't we addressed or should we look at when we're developing the PEIS? It will help us identify those concerns and also the need to identify things to mitigate those concerns or those potential problems that we address.

During these scoping meetings we ask that you have your comments sent to us postmarked by September 15, and once we receive those comments, we analyze them and categorize them according to these items here, what type of priority should we place on these comments, the level of detail that they include, the source of information, and also issues that need to be addressed and evaluated within the PEIS.

Public Scoping Transcripts 2003

16:26 We'll consider all comments that you provide while developing the draft PEIS. All comments that you provide during this public scoping meeting, either after this briefing here or during the

16:46 question-and-answer session that we have afterwards will be recorded so that we make sure that we get the right verbiage down that you want to ask in your question.

Written comments can be submitted on the

17:04 public comment sheets that are outside on the tables in the foyer, or you can fax, mail, or e-mail them to us. This is our address to mail them to. This is our fax number and our e-mail. If you have any concerns, you can send us an e-mail.

17:46 Also, the PEIS involvement would be on our web site, which you can see here, and it's in your handout, too, and also the phone number for the public affairs office.

Your copy of the future draft PEIS,

19:30 simply mark in the public comment portion that you'd like to get a copy of it, or you can e-mail us and request a copy, or there is a list of selected local libraries that will have it available for you to look at. Or you can download the entire draft PEIS on our

20:47 web site.

Public Scoping Transcripts 2003

:20:49 And throughout this whole process, we encourage you to provide comments. You can submit them to us, like I said, through e-mail, through -- by mailing them or faxing them to us.

:21:26 Sherry.

SHERRY: As Mike said, we're interested in your comments, and we'd like to have a question-and-answer session now. If you have any questions that you'd like to ask, we'll try to answer them.

:21:48 In addition, any comments that you'd like to make. Colonel Thomas and Mr. Demko, if you'd like to come up here to answer questions. There are some other subject matter experts in the audience that may (indiscernible).

:23:31 COLONEL THOMAS: Yes, sir.

UNIDENTIFIED SPEAKER: Should I use the microphone?

Can you hear? Okay. This is about (indiscernible) I'm (indiscernible) Anderson from

24:41 Albuquerque here with a group called the Committee to Stop the War, and we're very concerned about this whole issue of this project and the political implications of it more so than probably the environmental aspect, but that is an important question.

26:54 And one of my questions was we had

Public Scoping Transcripts 2003

written and asked for an additional (indiscernible) hearings to have a hearing in Albuquerque, which is the state's largest city, which is on the northern edge reaches of your -- we're going north with the large scale testing, we're in the southern edge of Albuquerque, we'll be getting an impact in large population areas.

I think it would be good to have a hearing up there because we'll get a lot more input from people, probably more critical comments and peer pressure than I would. So I'll go ahead and ask about that. Is there any response to that, whether we might do this in the future? **See Section 1.6**

COLONEL THOMAS: Let me ask our staff people to provide comment there.

SHERRY: We initially looked at the areas around this, the White Sands Missile Range, that are nearest to our testing activities and at this point we don't (indiscernible) locations. But we invite your comments from the public (indiscernible). We want to be sure that you understand that the effects of the testing are in a local area. We want that to be (indiscernible) perception. At this point we have publicized (indiscernible) time to come to these meetings and we are unable -- so that's

Public Scoping Transcripts 2003

(indiscernible).

But we do encourage your comments, however.

UNIDENTIFIED SPEAKER: Thank you. I would disagree with you. I think that in New Mexico, especially, when you have the whole state devoted to weapons testing and experimentation and all sorts of -- we're all one large community, and you should have hearings like this in Albuquerque, too. It's not just in the local, rural areas.

The socioeconomic and environmental effects of this, we're looking at things like nuclear weapons, threat reduction facility, expansions of WIPP, (indiscernible) Seinfield in Albuquerque where they do the uranium testing. Anyway, we've seen too much of these isolated approaches to the problems which affects all of us in the state. So I would encourage you to look at that. **See Section 1.6**

You talked about use of nuclear weapons simulants in these targets. Is that the impact of the target or is that from the delivery vehicles, also, such as cruise missiles? Because cruise missiles can carry nuclear warheads, also. Are you planning to simulate the impact of a nuclear weapon with a cruise missile?

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:41:00 COLONEL THOMAS: Quick answer, no. The use of radioactive simulants would be to simulate what could be in an adversary's weapons of mass destruction arsenal. The nuclear simulant would be a
:42:12 nonradioactive source, which would mimic the chemical and physical characteristics of what could be nuclear material in an adversary's (indiscernible).

UNIDENTIFIED SPEAKER: What kind of material would that be? Because they did tests like
:43:14 this at Sandia years ago and the whole South Mesa is contaminated with radioactive materials (indiscernible) search for and train people to find it. What would this material be? See Appendices E, F, G and H

COLONEL THOMAS: I'm not familiar with
:44:33 the Sandia tests at all. As far as the Defense Threat Reduction Agency, what we would use would be, for example, a nonradioactive cesium compound.

UNIDENTIFIED SPEAKER: You're a little deeper in science than I am. I'd like somebody to, you
:45:12 know, go a little bit further, if we could. I assume you're talking about short-range, short-lifetime isotopes of elements?

COLONEL THOMAS: No, I'm talking nonradioactive, not an isotope. See Appendices E, F, G and H

:45:44 UNIDENTIFIED SPEAKER: I'll have to look

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into that. This is why we need more preparation on this and we need a series of (indiscernible) where people can prepare questions. Because I would say that these things were rushed and came up upon most people pretty suddenly. And the hearings like this here, you people can -- (indiscernible) with very critical of it, I think. See Section 1.6

And I think that if you (indiscernible) honesty in your thinking, you want critical thought and presentations of all of these aspects of what you're doing, just for fairness.

One of the questions, when you talk about enlarged activities and the environmental impact of this, how large are we talking about on a scale? Are we doubling it or are we ten times the size? Because you're talking about many more tests and a much larger size of the tests. Can you put that in some commonsense characterization for us? See Section 2.0

COLONEL THOMAS: The majority of our tests we use existing test beds. I briefed specifically on the Capital Peak compound (indiscernible) and the expansion of granite phenomenology test sites. So, those are the specific expansion areas or test beds that will be included within the scope of a programmatic environmental impact

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53:05 statement.

UNIDENTIFIED SPEAKER: I understand test beds are the sites. But the impact and the environmental consequences of reaching out from this

53:25 area, are we talking about way out from the areas? I mean, I know you trying to contain it in a test bed. But if you're going to increase this, I mean, that must mean you're sitting here. Are you going to expand the size of the whole test range and the facilities itself.

54:51 Am I right on that? **See Section 2.0**

COLONEL THOMAS: No, sir. I was mentioning that with our current test bed locations and the types of tests that we run, we anticipate similar tests increasing in frequency and with the expansion of

55:08 some of our test site capability. For example, the Capital Peak tunnel complex and the phenomenology test beds, we want to make sure that in the safest way possible we are looking at any sort of potential impact that may be caused by potential test requirements that

56:00 come in for those test bed usages.

UNIDENTIFIED SPEAKER: Capital Peak is a tunnel for $6 million. You're going blow it up, and dig it out and then blow it up again. Is that what this comes down to?

56:17 COLONEL THOMAS: We anticipate that for

Public Scoping Transcripts 2003

potential tests using that complex, and if we use some similar tunnel complexes that are in Nevada, that this will be used over a 10-year period of time for various types of tests. Some of it may blow it up or blow portions of it up and cause some sort of damage, some of it may not.

UNIDENTIFIED SPEAKER: Is this going -- the thermobaric effect, is this like a fuel/air explosive bomb, where you want the outside explosive detonation to penetrate down inside the tunnel before it detonates itself? See Section 2.0

COLONEL THOMAS: No, sir. The fuel/air explosive is an explosive that is used in an open location. The thermobaric weapon requirement is one in which you take existing explosive fields and change some characteristics of its chemistry to increase its heat and pressure component. Normally, that would be used in a confined environment, for example, like a tunnel or a small environment where you would not have as much oxygen.

UNIDENTIFIED SPEAKER: Yeah, you talk about changing the mixture of the chemicals so that you get the different effect of the burning, and that's going to react with the target chemicals and the materials and things.

Public Scoping Transcripts 2003

COLONEL THOMAS: I'm sorry, I didn't catch the first part.

UNIDENTIFIED SPEAKER: I think I understand what you're saying. You're going to change the mixture of the impact explosives to see how it interacts with different targets explosives and materials and things like that.

COLONEL THOMAS: Yes, (indiscernible) sequence, yes.

UNIDENTIFIED SPEAKER: It would help if you-all put out some kind of a commonsense brochure on this explaining to the public what we're talking about on these things rather than folks coming here and trying to figure these things out.

You have a consequence management team in case -- for advice in case of use of these on targets of weapons of mass destruction. What would that look like in the final outcome? I mean, that's a very intriguing question, studying the consequences of the uses of these. How far are you going to go into that in your final document or when you're doing research?

See Section 4.0

COLONEL THOMAS: The Defense Threat Reduction Agency currently provides for our first-line responders in the United States, for antiterrorism force protection scenarios, which may include weapons

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of mass destruction, and for our combatant commanders and our war fighters overseas where weapons of mass destruction threat exists.

We provide the modeling capability to do two things. One is that if you are a war planner overseas supporting combatant commanders, this would give the people who plan our missions the capability to ensure that they match the appropriate weapon to the target to reduce any sort of collateral effect of the weapons of mass destruction material that may be contained inside that target, so that would minimize the adverse effects of that against both enemy troops and also domestics folks in the area.

The second application would be in order to provide first responders the capability, in case of a domestic consequence, in case they have a domestic weapons of mass destruction scenario, to calculate quickly the most adverse effects of that so they can put into motion an evacuation and other kinds of safety criteria to reduce the impact of that potential terrorist use of the weapons of mass destruction. Those are the two primary areas in which we do the consequence management assistance.

SHERRY: (indiscernible) is there someone else that has some other questions? And then we'll

Public Scoping Transcripts 2003

come back.

UNIDENTIFIED SPEAKER: It sounds like you're practicing on ways to deal with the situation of weapons of mass destruction and you can bomb that site or destroy a weapon of mass destruction. Is that right?

COLONEL THOMAS: I believe that the mission of the Defense Threat Reduction Agency includes an awful lot of areas. For example --

UNIDENTIFIED SPEAKER: That would be one.

COLONEL THOMAS: -- not only trying to (indiscernible) and the other application would be in that counterforce application against the weapons of mass destruction. **See Section 2.0**

UNIDENTIFIED SPEAKER: So I sounds like you would have to have some nuclear material involved in something like that. I mean, isn't that true, if you're going study the effects of bombing that weapon of mass destruction?

COLONEL THOMAS: No, not necessarily. The specific test requirements that come to us from the war fighter are very specific in nature, and it would -- and it could include weapons of mass destruction targets, to include a chemical or biological agent, or it could be a radiological agent.

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It could be any of those three.

UNIDENTIFIED SPEAKER: So this effort that you're doing the environmental impact statement for could involve chemical, biological, or nuclear material. **See Section 2.1.1**

COLONEL THOMAS: We use simulants for all the testing requirements. And as I mentioned earlier, those radiological simulants, those are not radioactive, and they mimic the physical and the chemical properties of a suspected radioactive source.

UNIDENTIFIED SPEAKER: How are the chemical and biological simulants different? I mean, it sounds like they are cousins of terrorism weapons.

See Appendices E, F, G, and H

COLONEL THOMAS: The chemical and biological agent simulants are, in the case of the biological simulant, for example, I can give you the example of bacillus aerogenes. It's a simulant that's currently used as an insecticide, and it then mimics the physical and I won't say chemical capabilities, but the organic capabilities of most biological threat agents. That is, again, currently used today in the United States as a pesticide.

For chemical agents, the most commonly used simulant is called DPGME. Currently, you normally hear it in industrial applications DPM. It's dipropyl

Public Scoping Transcripts 2003

16:51 glycol methyl ether. And again, these two simulants are commonly used in applications in the United States and have an established property background so that we can make an appropriate environmental assessment on 17:25 their use.

UNIDENTIFIED SPEAKER: And I guess I have one more question. I mean, a lot of insecticides and things that are used commonly really do have a harmful effect on a lot of people. And so I'm wondering if you 7:38 can tell me what are the possible harmful effects again of the substances that you're using. **See Appendices G and H**

COLONEL THOMAS: The Defense Threat Reduction Agency has (indiscernible) cases in priority. In the selection of any of its simulants, we would 4:57 ensure that the programmatic environmental impact statement would assess the risks and vulnerabilities of each of these simulants before we even use them. So we would ensure that either currently or in the future use of a simulant, that that would be hopefully addressed, 6:42 as well as all of the potential hazards that may be associated with their use.

Additionally, when we design and execute a test, we would ensure that we would only use the minimum quantities and the amounts that are required in 7:44 order to appropriately demonstrate the capability of

Public Scoping Transcripts 2003

17:47 the test and also to ensure safety and minimal spread of any of the simulants.

UNIDENTIFIED SPEAKER: Are the results listed somewhere today so that we will know what we

23:42 will be exposed to? **See Appendices E, F, and G**

COLONEL THOMAS: Yes, ma'am, they are.

UNIDENTIFIED SPEAKER: Where are those right now? I mean, where is the list? I don't remember seeing them out on the table out there.

25:23 COLONEL THOMAS: Let me refer that to (indiscernible).

UNIDENTIFIED SPEAKER: The simulants we are using now are published in the environmental assessment that was published 18 months ago. The

25:53 answer to your quick question, what we will be using, that will be published next year when we publish the draft EPIS. There will be an (indiscernible) that lists each and every simulant that will be considered for use. So it will be -- when that -- Mr. Demko

27:42 briefed all the places that will be available. That list will be published in there.

Right now, we are still trying to determine what are some of the possible simulants that will be used in operational needs and safety and health

8:55 issues, et cetera.

Public Scoping Transcripts 2003

UNIDENTIFIED SPEAKER: So by the time that draft is published, the decisions will have been made? **See Section 1.6**

UNIDENTIFIED SPEAKER: No, the decision will not be made until after the draft is published, public comments and regular comments are incorporated, go back and make a final, and so the decision will be made in the very last step.

UNIDENTIFIED SPEAKER: So that we will be able to make another comment after we've seen the list?

UNIDENTIFIED SPEAKER: Oh, yes, ma'am.

COLONEL THOMAS: Yes, ma'am.

UNIDENTIFIED SPEAKER: When that draft comes out, it will have a simulant list? We expect a much more concrete conspect once you-all document the common time versus just a briefing environment. **See Appendices E, F, G and H**

SHERRY: Any other questions?

UNIDENTIFIED SPEAKER: Two quick questions. All of this is going to happen within White Sands?

COLONEL THOMAS: Yes, sir, (indiscernible) White Sands Missile Range.

UNIDENTIFIED SPEAKER: Any buffer zone (indiscernible) is there a five-mile buffer zone around the periphery that occurs within that five miles, or

Public Scoping Transcripts 2003

can it occur right by the fence of White Sands? How close to the fence can all this occur? **See Section 2.0**

COLONEL THOMAS: The testing that we do, prior to each test we establish what we call a weapon safety footprint to ensure that we understand, based on the type of weapon that we are testing, what the maximum effects would be. And this is put through a (indiscernible) process. We go and execute the test.

Pertaining to simulants, we make sure that we use the minimum amount of approved simulants to reduce the possibility or the probability of any sort of release outside of the immediate test bed location.

Additionally, when we execute the test, we ensure that we monitor the weather conditions, the wind, temperature, to ensure that there won't be any weather-induced effects that would adversely create a scattering of any of these simulants. **See Section 2.1.1.2**

Hope that answers your question.

UNIDENTIFIED SPEAKER: I guess the second question is kind of general. What is your canary in the mine that tells you that you're not -- canary is not going to die. **See Section 2.1.1.2**

COLONEL THOMAS: I think I understand the question, sir. For many of our tests which include simulants, we ensure in the test bed design that we

Public Scoping Transcripts 2003

13:41 have arrays of samplers and detectors so that we understand -- first, we go through the modeling and prediction before we conduct the test.

Based on quantity of simulants and the 14:21 type of (indiscernible) that's being tested, we would look at a worst-case scenario. We would ensure that the material, the quantity, and the type of simulants, to minimize the sort of potential for spreading that simulant. We then go ahead and set up an array of 15:47 samplers and detectors (indiscernible) test bed, and then outside of the test bed location.

We then, right before the test, ensure that we track surface and upper level winds, and then only when those winds are within the parameters to 17:22 ensure that we wouldn't have any sort of a (indiscernible) spread, we would then, and only then, conduct the tests.

So the canary, essentially, would be the array of samplers and detectors we would set up right 18:45 around the immediate test site. And then we also have, looking at White Sands missile range, samplers outside that immediate test range to ensure that we know what the effects would be, if any, from the simulants that we are using. **See Section 2.1.1.2**

20:35 UNIDENTIFIED SPEAKER: You have quite a

Public Scoping Transcripts 2003

large population of wildlife on White Sands, and I know you have a range scientist that looks at plant life and that (indiscernible) will those people be involved, if something happens? **See Sections 3.2 and 4.2**

COLONEL THOMAS: Yes, sir. Yes, sir. As far as answers on safety, that would also include the wildlife, plant life, and...

SHERRY: Are there other questions?

UNIDENTIFIED SPEAKER: I do. Actually, I had forgotten about the national wildlife issue -- refuge. I mean, that's enough reason for another action alternative on this case, anyway, because we are trying to expand the national wildlife refuge around here in the state of New Mexico. We don't need more dispersals in the air. **See Section 2.1.1.2**

I just think back about the Nevada Test Site, I mean, Saint George Utah (indiscernible) supposedly the meteorology was all (indiscernible) but now we've got people all over Utah dying of cancer because of the fallout from the ranges. And we don't even know exactly what you're going to be testing here. But to me, it's just not -- sounds too shaky. **See Section 2.1.1.2**

But going ahead to the cruise missile thing for a second, are they going to be making modifications to the cruise missile warheads that are

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going to be impacting these targets for tests? Are they going to be carrying anything different besides the standard cruise missile?

COLONEL THOMAS: The tests that we have conducted and anticipate will be conducted at White Sands use a conventional high explosive warhead on cruises. I don't know what your question was as far as the standard --

UNIDENTIFIED SPEAKER: Yeah, what I'm -- I'll mention it in the context of what I'm trying to get at here, which is really the distinctions, talking about where is the distinction between nuclear and conventional weapons and how one prepares so that they can use, step up the grades and the size of conventional weapons and (indiscernible) nuclear weapons capability so they can sort of cross that threshold, and the next thing you know, we're in a nuclear war where we're all at stake, and the political implications of that are horrendous.

And I'm fishing around trying to find out if this is the (indiscernible) do we help prepare us and the public for, you know, moving slightly over and we've got have a bigger warhead (indiscernible) because the granite tunnels are a little bit harder than we thought they were, or something like that. Is that a

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56:49 possible scenario coming out of this?

COLONEL THOMAS: First of all, the Defense Threat Reduction Agency shares your concerns about safety. Your question about the cruise missile, 58:00 I'm (indiscernible) not quite understanding what you're really trying to ask on that.

UNIDENTIFIED SPEAKER: Well, you can change the warheads on a cruise missile pretty easily from conventional to nuclear, right?

58:29 COLONEL THOMAS: I would think so. I'm not an expert on cruise missiles.

UNIDENTIFIED SPEAKER: All right. So let's assume you could (indiscernible) I'm just saying that (indiscernible) against a hardened target, 01:02 possibly. I'm just asking if that's a possibility.

COLONEL THOMAS: No, sir. The programmatic environmental impact statement process is an open process in which we will publicly show and solicit inputs for each particular test requirement 01:38 that we conduct. And so I share your concern. I live in Albuquerque myself, so clearly, being an individual that lives in Albuquerque and enjoys New Mexico, we all are concerned about the environment.

UNIDENTIFIED SPEAKER: Yeah, right. I 02:39 think that we ought to be more concerned

Public Scoping Transcripts 2003

(indiscernible) the population all around here, I think we need less testing than more. I'd like to see in the report when it comes out (indiscernible) on the impacts of this, the effects upon the state of New Mexico, for example, of the presence of the military industrial complex here. We have more, trillions of dollars of military weapons spending go through here, highest rates of poverty. People without schooling and education are going to be building these (indiscernible) people that are homeless. I mean, this stuff doesn't make sense. **See Sections 3.11, 3.12, 4.11, and 4.12**

I'd like to see something in the study that addresses this issue, the economic impacts of just this program and its relationship with what's going to happen in terms of poverty in the state, what it's going to do to increase the whole message of violence. It's going to accept -- people accept that violence is a rational solution to the social and economic problems in other places and the political differences, that also should be addressed in this, too, as a part of the social environment that we're having to deal with. And I'd like to see your study expanded into those areas.

COLONEL THOMAS: Sir, if I remember correctly, in Mr. Demko's -- he is more of an expert than I on this -- but one of the versions of the

Public Scoping Transcripts 2003

18:55 programmatic environmental impact statement is an area which emphasizes and looks at the socioeconomic aspects.

UNIDENTIFIED SPEAKER: Well,

20:02 (indiscernible) because I've read a lot of these in the past, and none of them really go far enough and try to balance that off, why so much spending on high technology and so much poverty and socioeconomic problems. And actually, that should be addressed in

20:45 this, I think.

Just one last question I've got (indiscernible) at this. Has any (indiscernible) I mean, your place there, you've probably got 3,000 weapons of mass destruction stored right there. Has

22:32 there been any kind of study done on that if there is a problem or detonation or a dirty bomb effect from (indiscernible) I don't mean a terrorist coming in and detonating a small little vehicle. But I mean with that stockpile there, where could we find information

24:16 about that and look at that problem?

COLONEL THOMAS: Sir, the Defense Threat Reduction Agency is a distinct unit from Kirtland Air Force Base. I don't know any of that information that you're requesting. And I would ask that if you want

26:05 information, I know that Kirtland Air Force Base has a

Public Scoping Transcripts 2003

public affairs organization, you can probably start getting information. I personally do not know any of that information.

UNIDENTIFIED SPEAKER: Can you tell me what the budget for the agency was in the three years preceding 2002?

COLONEL THOMAS: I'm sorry, I didn't hear your question.

UNIDENTIFIED SPEAKER: Can you tell me what the budget for the agency was in the years 2000, 2001, and 2002 -- no, 1999, 2001, and 2002.

COLONEL THOMAS: Ma'am, I don't have that information. What you can do is if you can write that down, I'll make sure you get that information back. I do not know that.

UNIDENTIFIED SPEAKER: Okay. And I'm wondering if you would consider changing the name. It says making the world safer. I would propose you are making it far less safe. I think you're attempting to make the U.S. safer, but I don't think that's really happening either. I think you're playing with things that can -- it's sort of the same thing as cleaning your house before you blow it up.

And I think the environmental impact statement, while it is important, is not nearly as

Public Scoping Transcripts 2003

important as looking at what you're doing altogether, because I think raising the number of weapons and the sophistication of our weapons simply begs the rest of the world to do the same.

SHERRY: Any other questions?

UNIDENTIFIED SPEAKER: Are you in the question stage, questioning the presenters, or in the comment period of gathering public comment to go into the scoping portion, the scoping document of this?

SHERRY: We are taking questions right now to provide answers. If someone wishes to make a comment now, you can do that within that (indiscernible) separately, but you can also submit separately (indiscernible).

UNIDENTIFIED SPEAKER: So you're also accepting comments, scoping?

SHERRY: Yes.

UNIDENTIFIED SPEAKER: Thanks. Literally in the list of your issues you're scoping, I would like the following issues considered. I want to make sure that the previous environmental assessment data limits set on the simulant properties and quantities of simulants, all other limiters to the project that currently DTRA proceeds with, the various projects that they proceed with on WSMR, that all of that data be

Public Scoping Transcripts 2003

available to the public probably in the PEIS and with the PEIS when it comes out. See Appendices E, F, G, and H

I think it's really important to build upon that baseline data for the public and the decision-makers to understand and thoroughly analyze what it is that's expanding, what it is it's increasing, rather than not just physical units constructed and operated on range. But looking at the limiters that came out of that DEA and EA process. That was a couple years ago, right? See Section 4.0 and Appendices E, F, G and H

So that will be the first issue. I just bring up. It's a little bit odd to go back and re-publish that, but please go back and try to analyze that, that alteration, that expansion and change.

Biologically, out there on the range, this chronic wasting disease that blew everybody's socks off when it showed up in the deer population in seven regions of the range. So, please, on that note, make sure that the PEIS thoroughly analyzes all wildlife in great detail, especially in the northern extent of the range, in those mountains, and in the plains and desert and any ephemeral riparian areas.

See Sections 3.2 and 4.2

I've seen those creeks run (indiscernible) during the rainy season, so I want to look at all that in relation to every one of those

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simulants and in relation to every one of those explosive components that might be used. So that may expand your document just a little bit. **See Sections 3.1 and 4.1**

Economic consequences, cultural consequences, I think it's very important to really (indiscernible) and analyze a new action alternative and very limited action alternative for a diminution of your activities right now that you site on the range, what effects that would have. **See Sections 3.11 and 4.11**

And it really, you know, the public has been calling for this for years. We really need to analyze what happens to the economics of this nation if we cut it out as far as the arms race goes, because we're in a unilateral arms race now. We really haven't found great dangerous and threatening caches of weapons of mass destruction, whereas we're now calling all chemical and biological agents that we probably deposited in the territory of some of our current enemies and their caches of weapons.

And it's very, very minor compared to what we contain ourselves. We're the ones on earth with the most dangerous caches of weapons, and we're not proposing giving up any of that. We're proposing expanding those capabilities and our stewardship and our maintenance of those weapons. And that's not

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making the world a safer place. It's making the world a more dangerous place.

But to be specific as far as scoping here, as far as an issue, please analyze what cutting the defense budget in this country could do for the economics of many, many sections of society, and you can go ahead and extrapolate what that would do for this region of New Mexico (indiscernible).

As far as the next issue goes that I jotted down -- and I'm sure there are many, many more -- full disclosure of known effects of the proposed simulants. I'm sure you'll do that anyway. I wanted to just make sure it gets on the record tonight.

See Appendices E, F, G and H

The hydrologic basin underneath the range, you know, many of us are aware that our hydraulic basins are not -- we're not finished studying. We're not (indiscernible) surprises are coming up as we do that work that's mandated now. And we need to know what's going on to the hydrology under the range with all this explosive activity, plus we need to know how contaminants could possibly seep in through fracture zones, and that's going to need to be in the EIS if it's not in the EIS. **See Sections 3.1 and 4.1**

The interplay between all other client agencies that utilize the missile range, other tenants

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on the range, interplay between their programs and this program and this proposal. I think it would be very helpful (indiscernible) so far as to create environmental assessments and EISs for some of those projects and some of that activity. **See Section 5.0**

We really need to see in your document some sort of connection, some sort of larger picture about all that goes on on the range as far as testing activities go. It's a really big piece of land. I know that you folks are very, very efficient in your use of it. You're very, very (indiscernible) of the people living out there. You want it to be a safe environment. **See Section 5.0**

You know by now my overall attitude is this is making the world a less safe place, but let's really look at the interplay, the environmental issues of range activity with environmental issues of all of this proposed action. **See Section 5.0**

And then let me just check my notes here. You spoke of treaties, sir, and we are signatory to a couple of ratified treaties, ratified by the United States Senate, the Nonproliferation Treaty and the Limited Test Ban Treaty of 1963 and the space treaty, Space for Peace. **See Appendix A**

I'd like to go on record tonight as

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making a statement that we are in gross violation of being party to all three of those treaties. And we're not disarming nuclearly. And Pakistan and India made it very, very clear when they tested that -- and they made it clear for years before they tested -- that if we would only inhabit the Comprehensive Test Ban and all the (indiscernible) hard work from 1973 when we began the PT treatment and get rid of nuclear weapons and disarm and start a trend of work on diplomacy and negotiation and (indiscernible) and we are great friends to many people in the world, but we would become friends to our enemies and try to figure out how that the world would, indeed, become a safer place, and there would be a lot less money spent on the range and there would be a lot less money spent at Kirtland and everyplace else.

All of you would start working on something that maybe (indiscernible) something that you might feel a lot better about doing. We have a lot of work to do to figure out how to live on this planet with this population and these threats and these animosities, and you know that this ship needs to be turned midstream. We're headed straight for the iceberg. It takes a lot of time to turn a ship.

So I hope that the action alternative or

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any limited action alternative to any degree is the outcome of this procedure. I know that's very Pollyanna, that's very unrealistic. It's full steam ahead right now. I think you guys all in your souls know where we're headed. And I hope that each one of you in a (indiscernible) way you can helps stop this and stop this economic drain and stop this big business, because your handlers are making the profit.

See Sections 3.11 and 4.11

The entirety of it isn't about (indiscernible) really. It isn't about (indiscernible) of the analyses that are coming out. It's about profit margin for a few very large corporations, who are on top of the pile because they are weapons developers, weapons contractors, and all of that, and you're just all part of it.

And so are we all. That's why we need the money, to try to help mitigate that. To mitigate it in every way you can. My ten minutes is probably up. Thank you.

SHERRY: Someone else?

UNIDENTIFIED SPEAKER: I'd like to know how many people who are in this room are either directly employed or indirectly employed by this project?

And now I'd like to ask you if you like

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31:55 your jobs. I'm asking that because -- do you like your jobs?

UNIDENTIFIED SPEAKER: Yes.

UNIDENTIFIED SPEAKER: Okay. I'm asking 32:11 that because I grew up in a household of a man who loved his work as well and he began as a rocket scientist in Germany, and it took until I was almost an adult to find out what his work really entailed. I knew he was a rocket scientist, and mostly what I knew 32:30 was that he was working on missile shots at the moon.

And I also knew that he designed the steering system for the V2s that landed on London. And because I'm German, full-blooded, came to this country as a young child, I was aware that my family was made 33:22 up of good men and women just like you-all are sitting here.

I was also aware that they believed in their work. There was a camaraderie, there was a synergy about what they did that allowed them to go far 33:51 beyond their individual talents. They loved their work and they thought ultimately what they were doing was making the world safer.

But you know what? The world was a lot safer then. It was decidedly unsafe for certain 34:05 people, and the world now is becoming more and more

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unsafe for certain people. I've noticed that people who are our enemies are different in skin color. I was lucky. I spoke with a German accent when I was a little kid. But beyond that, people didn't know I was one of them.

But when I was really little in Alamogordo, I was one of them, and I couldn't understand for years why I was disliked. And we still haven't dealt with those problems. And I submit to you, just like the speaker before me, that there is a different way to be in this world, and under the skin, we're all the same.

And if your logo up there had a view of the world, you would see that it's only one world. It's round, and whatever you put in the air here, whatever you plunge into the earth affects everyone. But you know who it affects most is those who are closest and who are working with it.

And I think what my father said to me -- I worked with kids all my adult life and he never seemed to care -- but his last cogent words to me were, "It's the children who really matter." And I work with kids right now who have language and developmental delays, and I want to tell you it's affecting more and more people's children to a degree that nobody is safe

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from it.

If you look very far, you'll find an autistic child among you. You will find a child among you who will grow up with Parkinson's because of those very insecticides that we think we're spraying so safely. If you really want to make the world a better place, a safer place, you need to include everyone in your world.

I've been on both sides of the war and I know what it's like when you look at it in retrospect. And believe me, my father went to his grave, number one, thinking Germany had been right; number two, thinking the U.S. was right. And as I look back over there on his life and so many of the people I grew up with, you know what? It wasn't right.

And it's not right now. And you guys have an awesome responsibility on your shoulders, and I hope that your hearts and your consciences will wake up and you'll understand that any of those bombs you create make everyone less safe. Thank you.

SHERRY: Any other comments or questions?

UNIDENTIFIED SPEAKER: I guess I'd like to follow up on what she said and what he said about socioeconomic resources. I see there are a lot of people in this room that you employed by this and love

Public Scoping Transcripts 2003

their jobs. And I am not employed by this and I love my job. I'm a fourth grade teacher. And I noticed that the more money goes into weapons production in this state, it seems like the poorer my students become. And this is the poorest state in the country, and also the state that has the most nuclearism as far as nuclear weapons and uranium mining and all the other things that go on, dumping.

And people keep saying that this is providing jobs. Since we're talking about socioeconomic resources, I would suggest to you that if military jobs really enhanced our economy, the whole state of New Mexico would be living like emperors, and we sure aren't.

And my students are some of the poorest kids in the state. For the last seven years I've taught here and for all of those seven years I've taught impoverished children from impoverished families. And so I would like to say, as part of this socioeconomic resources, that what we need for our resources industries that are actually going to be able to be used by the families in this state.

Unfortunately, if these are going to be used, it's just going to create for war or further more war or enhance more war, which means more money is

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taken out of education. I can get up here and testify to that, and healthcare and all the other things that we really do need here.

The money is not going to those things. They keep saying there is not enough money, but there is $200 billion in a fingersnap's time when we want to go and take the oil from Saddam. So as far as socioeconomic resources, I really think your detailed study of how these kinds of things are affecting our economy would really be important to include. **See Sections 3.11 and 4.11**

Because from where I'm standing and where I'm sitting, kids are getting poorer and sicker and thinner, and I don't have enough money to teach them. I'm having to pay for stuff myself. Something is wrong here with this picture. Please include an analysis of the economy of this state.

SHERRY: Any other questions or comments?

UNIDENTIFIED SPEAKER: Just one other quick one. I live a block and a half from (indiscernible) Park. I was on my way to (indiscernible) the other morning and one sad young man blew the head off another young man with some handguns. And I want part of the impact statement to be that these adults waging war against each other, how does that help the way kids treat each other?

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48:37 And I would propose to you that we are losing many, many more children domestically through violence and all kinds of other social costs than we'll ever lose in the war in Iraq or even aggression against

:50:54 our own country.

SHERRY: Additional comments or questions?

Thank you for coming. I (indiscernible) your comments and questions, and we appreciate it.

:52:07 (Meeting adjourned.)

Public Scoping Transcripts 2003

Transcription of PEIS Briefing, 14 August 2003 Alamogordo, New Mexico

Transcripts of Video Not Prepared. General Public Not in Attendance.

Public Comments 2006

United States Environmental Protection Agency, Region 6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

MAR 17 2006

Rcvd. 3/22/06

Ms. Cheri Abdelnour
Public Affairs Operations
Defense Threat Reduction Agency
DTRA/BDOE
1680 Texas Street SE
Kirtland AFB, NM 87117-5669

Dear Ms. Abdelnour:

In accordance with our responsibilities under Section 309 of the Clean Air Act, the National Environmental Policy Act (NEPA), and the Council on Environmental Quality Regulations (CEQ) for Implementing NEPA, the U.S. Environmental Protection Agency (EPA) Region 6 office in Dallas, Texas, has completed its review of the Draft Programmatic Environmental Impact Statement (DPEIS) for the proposed Defense Threat Reduction Agency (DTRA) activities at White Sands Missile Range, New Mexico.

EPA classified your DEIS as "**LO**," i.e., EPA has "**Lack of Objections**" to the proposed alternative. However, we have enclosed some detailed comments for your consideration in finalizing the PEIS. Our classification will be published in the Federal Register according to our responsibility under Section 309 of the Clean Air Act, to inform the public of our views on proposed Federal actions. 1 - 1

EPA appreciates the opportunity to review the DPEIS. We request that you send our office one (1) copy of the Final PEIS at the same time that it is sent to the Office of Federal Activities (2251A), EPA, 1200 Pennsylvania Avenue, N.W., Washington, D.C. 20044.

Sincerely yours,

for Rhonda M. Smith, Chief
Office of Planning and
Coordination (6EN-XP)

Enclosure

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DETAILED COMMENTS FOR THE DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT DEFENSE THREAT REDUCTION AGENCY ACTIVITIES WHITE SANDS MISSILE RANGE, NEW MEXICO

COMMENTS

This proposed project to expand the weapons testing program at the White Sands Missile Range potentially affects multiple counties in New Mexico: Socorro, Otero, Sierra, Lincoln and Doña Ana. Although parts of Doña Ana County are in nonattainment of the PM10 National Ambient Air Quality Standards (NAAQS), the designated nonattainment area does not overlap with the White Sands Missile Range installation. Since the remaining counties are in attainment of all NAAQS, transportation and general conformity regulations do not apply. 1 - 2

Table 3-7 on p. 3-59 lists the criteria pollutants and contains a reference to the 1-hour ozone standard. A new 8-hour ozone standard has been promulgated by EPA and the 1-hour standard was revoked on June 15, 2005. EPA suggests adding the 8-hour ozone NAAQS of 0.08 ppm to this table. 1 - 3

EPA has also promulgated a new particulate matter standard for fine particulate matter, $PM_{2.5}$; this standard is in addition to the existing PM_{10} standard. Please add the $PM_{2.5}$ information to complete Table 3-7: the annual $PM_{2.5}$ standard is 15 $\mu g/m^3$ and the 24-hour standard is 65 $\mu g/m^3$. 1 - 4

Public Comments 2006

United States Department of Interior, Office of Environmental Policy and Compliance

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
P.O. Box 26567 (MC-9)
Albuquerque, New Mexico 87125-6567

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

March 28, 2006

Via Electronic Mail

File 9043.1
ER 06/089

Defense Threat Reduction Agency
ATTN: WSMR PEIS Comments
1680 Texas Street, SE
Kirtland Air Force Base, NM 87117-5669

Dear Madam/Sir:

Thank you for your request for our review of the Draft Programmatic Environmental Impact Statement (DPEIS) for Defense Threat Reduction Agency (DTRA) Activities on White Sands Missile Range, New Mexico. The U.S. Department of the Interior offers the following comments for your consideration as you prepare the final document.

Biological Resources
Issues needing to be clarified or addressed in the final PEIS include:

- Potential impacts to threatened and endangered (T/E) plant species in the Oscura Mountains 2 - 1
- Potential impacts on species associated with limestone habitat 2 - 2
  - *Perityle staurophylla*– NM rock daisy
  - *Sibara grisea* – Gray sibara
  - *Thelypodiopsis purpusii* – Purpus tumblemustard
- Potential impacts to rare populations of *Polygola rimulicola* var. *escalerorum* (Mescalero milkwort) currently limited to two small areas with less than 200 individuals in the southern part of WSMR and the San Andreas Mountains 2 - 3
- Potential impacts to *Penstomen alamosensis* (Alamo Canyon Andres beardtongue) 2 - 4
- Potential mutagenic effects of biological and chemical agents to T/E plants 2 - 5

Public Comments 2006

2

- Has informal consultation been conducted with the appropriate U.S. Fish and Wildlife Service, Ecological Services Field Office (ESFO)? The Threatened and Endangered species (section 4.2.1.4) addressed in the PEIS have determinations of "may affect, not likely to adversely effect," which calls for informal consultation with FWS. A Biological Assessment (BA) or Biological Evaluation (BE) should have been completed and a concurrence letter from the ESFO included in the appendix PUBLIC AND REGULATORY AGENCY COMMENTS with the T&E list for Dona Ana, Lincoln, Otero, Sierra, and Socorro Counties, New Mexico. 2 - 6

Air Quality

Will tests be conducted during inclement weather (i.e., inversion layer, rain, or wind)? What is the estimated amount of greenhouse gases releases (i.e., per day, month, or year)? In the PEIS it is mentioned that of some of the gases to be used in testing are not restricted; what agency provides the guidelines for the use of these gases? 2 - 7

Geology and Soils

During recovery efforts for craters and depressions, where will the soil for backfilling originate? Are these associated borrow pits for the backfill material on White Sands Missile Range (WSMR)? Where and how will contaminated soil be disposed? Is there current data available to analyze the impacts to soils from the current testing sites? Would testing explosions result in earth cracks in areas outside the proposed project area? 2 - 8

Environmental Justice

Have the surrounding communities been properly consulted throughout the EIS process? The PEIS does not identify that minority and/or low income communities have been consulted. How many times will flyovers occur over minority and/or low income communities (i.e., day/night or 24 hours)? Is there current data available that analyzes the vibration levels and impacts to homes (i.e., vibrating windows, cracked foundations) resulting from aircraft flyovers?

2 - 9

In general, it is evident that the proposed alternative and alternative two will have the potential to result in moderate to severe impacts to all resources on the WSMR. We recommend that data be collected annually, throughout the life of this ten (10) year PEIS to accurately assess cumulative effects to resources.

Thank you for the opportunity to review and comment on this Draft EIS.

Sincerely,

Stephen R. Spencer

Stephen R. Spencer, Ph.D.
Regional Environmental Officer

bcc: Director/Deputy Director, DOI/OEPC, Washington, DC

Public Comments 2006

State of New Mexico Environment Department

State of New Mexico
ENVIRONMENT DEPARTMENT
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Harold Runnels Building
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BILL RICHARDSON
GOVERNOR

RON CURRY
SECRETARY

DERRITH WATCHMAN-MOORE
DEPUTY SECRETARY

RCVD 3/7/06 PM

March 2, 2006

Defense Threat Reduction Agency
PEIS Public CommentsATTN: BDQE
1680 Texas Street SE
Kirtland Air Force Base, NM 87117-5669

Dear Sirs:

RE: DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT FOR DTRA ACTIVITIES ON WHITE SANDS MISSILE RANGE, NEW MEXICO; VOLUMES I & 2 (JANUARY 2006)

This transmits New Mexico Environment Department (NMED) comments concerning the above-referenced Draft Programmatic Environmental Impact Statement (DPEIS).

SURFACE WATER QUALITY

The U.S. Environmental Protection Agency (USEPA) requires National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) coverage for storm water discharges from construction projects (common plans of development) that will result in the disturbance (or re-disturbance) of one or more acres, including expansions, of total land area. It appears that several of these discrete areas may exceed one acre (including staging areas, etc.), and will therefore require appropriate NPDES permit coverage prior to beginning construction (small, one - five acre, construction projects may be able to qualify for a waiver in lieu of permit coverage - see Appendix D). In addition, since these areas are grouped under one project and Environmental Assessment, this may represent a common plan of development, and thus the entire project may require permit coverage. 3 - 1

Among other things, this permit requires that a Storm Water Pollution Prevention Plan (SWPPP) be prepared for the site and that appropriate Best Management Practices (BMPs) be installed and maintained both during and after construction to prevent, to the extent practicable, pollutants (primarily sediment, oil & grease and construction materials from construction sites) in storm water runoff from entering waters of the U.S. This permit also requires that permanent stabilization

Public Comments 2006

DTRA/DPEIS
March 2, 2006
Page 2

measures (revegetation, paving, etc.), and permanent storm water management measures (storm water detention/retention structures, velocity dissipation devices, etc.) be implemented post construction to minimize, in the long term, pollutants in storm water runoff from entering these waters. In addition, permittees must ensure that there is no increase in sediment yield and flow velocity from the construction site (both during and after construction) compared to pre-construction, undisturbed conditions (see Subpart 9.C.1)

You should also be aware that EPA requires that all "operators" (see Appendix A) obtain NPDES permit coverage for construction projects. Generally, this means that at least two parties will require permit coverage. The owner/developer of this construction project who has operational control over project specifications (probably WSMR in this case), the general contractor(s) who has day-to-day operational control of those activities at the site, which are necessary to ensure compliance with the storm water pollution plan and other permit conditions, and possibly other "operators" will require appropriate NPDES permit coverage for this project. 3 - 1 cont.

The CGP was re-issued effective July 1, 2003 (see **Federal Register/Vol. 68, No. 126/Tuesday, July 1, 2003** pg. 39087). The CGP, Notice of Intent (NOI), Fact Sheet, and Federal Register notice can be downloaded at: http://cfpub.epa.gov/npdes/stormwater/cgp.cfm

In addition, operation of these types of facilities may require Storm Water Multi-sector General Permit (see Federal Register/Vol. 65, No. 210/Monday, October 30, 2000) coverage. Impact areas, fueling and material handling areas, soil remediation activities, etc. likely qualify as potential sources of pollution which may reasonably be expected to affect the quality of storm water discharges, from activities that meet the USEPA definition of "industrial activities" under Sector K and/or L, and possibly other sectors. This permit also requires preparation of a SWPPP, and installation of appropriate storm water runoff control practices (per the SWPPP). 3 - 2

Although there appears to be little potential to discharge pollutants to "waters of the United States" from the proposed activities, WSMR already has NPDES Storm Water Multi-sector General Permit coverage (NMR05A057) for various other industrial activities at this facility. The permittee should amend the existing Storm Water Pollution Prevention Plan to incorporate any additional activities and pollutant controls dictated by this proposed action.

GROUND WATER QUALITY

DTRA evaluates the ability to counter and defeat weapons of mass destruction (WMD). WMDs include chemical, biological, radiological, and nuclear weapons; and high explosives. DTRA conducts tests at WSMR to assess the impact and movement of WMD agents, and tests warhead penetration through soil and bedrock against mock enemy targets (i.e., subsurface bunkers). The proposed actions at WSMR include: collateral effects testing using chemical, biological, and radiological simulants; hard rock penetration testing; high explosive testing; anti-terrorism tests; development of weapon effects targets and test beds; and infrastructure improvements to the administrative complex (including replacement of trailers with pre-engineered temporary structures and expansion of water and wastewater service to the existing test control building).

Public Comments 2006

DTRA/DPEIS
March 2, 2006
Page 3

Information contained in the DPEIS indicates that numerous test materials (e.g., simulants) could be released during testing. Up to 64,000 gallons per year of each simulant could be released within a confined test structure; up to 16,000 gallons per year of each simulant could be released from unconfined containers (i.e., not confined within a test structure); and up to 1,800 gallons per year of each simulant could be released from crop-duster aircraft above a test bed. Information provided by the DPEIS demonstrates that these simulants can have adverse effects on human health and the environment.

Three ground water monitoring wells were installed at an existing test bed (PHETS) in 2000 and 2001 to assess any testing-related impacts to ground water. Ground water was encountered at depths ranging from 72 to 252 feet below ground surface. Nitrate was detected in ground water ranging from 3 to 10.8 milligrams per liter (mg/l). These concentrations are reportedly consistent with historical data for the area collected prior to any appreciable testing that used ammonium nitrate-fuel oil mixtures. However, petroleum hydrocarbons were detected in ground water samples from the monitoring wells ranging from 0.02 to 1.32 mg/l. Triethyl phosphate, a water-soluble simulant used in prior testing, was not detected in ground water samples from the monitoring wells; however, the sample quantitation limit was not specified. Ground water samples from the monitoring wells indicated total dissolved solids (TDS) concentrations ranging from 3,289 to 3,847 mg/l. These concentrations were determined to be consistent with historical data.

Ground water in the proposed testing area is protected under the Water Quality Control Commission (WQCC) Regulations due to TDS concentrations less than 10,000 mg/l. Given data suggesting that constituents (petroleum hydrocarbons) released from prior tests have migrated to ground water and the potentially significant volumes of simulants that may be released to the environment during future tests, DTRA testing activities at WSMR must be conducted pursuant to a ground water discharge permit issued by the NMED. A complete discharge permit application should be prepared and submitted to the Department's Ground Water Quality Bureau (GWQB) for review. In addition to contaminant releases from testing activities, domestic waste discharges from the administrative complex should also be addressed in the discharge permit application so that domestic waste discharges may be included in a discharge permit. 3 - 3

Execution of the project (construction activities at the administrative complex; construction of weapon targets and test beds) will involve the use of heavy equipment, thereby leading to the possibility of contaminant releases (e.g., fuel, hydraulic fluid, etc.) associated with equipment malfunctions. The GWQB advises all parties involved in the project to be aware of discharge notification requirements contained in Section 20.6.2.1203 NMAC. Compliance with the notification and response requirements will ensure the protection of ground water quality in the vicinity of the project. 3 - 4

HAZARDOUS WASTE

We would like to make three observations in this area:

Public Comments 2006

DTRA/DPEIS
March 2, 2006
Page 4

- When test weapons impact on-site, as expected, the White Sands Missile Range (WSMR) is exempt from RCRA. However, if WSMR manages the crash sites and contaminated soil, as required by their Stewardship program, then WSMR's remediation and recovery efforts may be subject to RCRA Subtitle C and/or D. Management of contaminated media and newly created waste associated with crash debris and contaminated soil is potentially subject to RCRA. 3 - 5

- If a test weapon crashes off-site, then WSMR is subject to the Military Munitions Rule (see Subpart M to 40 CFR 266). This scenario is not addressed in the DPEIS. 3 - 6

- Nitrate concentrations have already exceeded Safe Drinking Water Act Standards and the Water Quality Control Commission (WQCC) standards in monitoring well MW-01-3 and many of the materials (high explosives and propellants) used in the tests are sources of nitrogen. If a test weapon crashes on-site in the aquifer recharge zone, then WSMR may be subject to WQCC and/or Drinking Water Regulations. 3 - 7

AIR QUALITY

Further information is needed to determine if air quality impacts would result from the proposed project.

These activities are exempt from New Mexico air quality permitting requirements in accordance with 20.2.72.202.A.5 NMAC, which states that "Government military activities such as field exercises, explosions, weapons testing and demolition to the extent that such activities (a) do not result in visible emissions entering publicly accessible areas; (b) are not subject to New Source Performance Standards (NSPS) or National Emissions Standards for Hazardous Air Pollutants (NESHAP)". There are substances in Appendix F that are listed under 20.2.72.502 NMAC – Toxic Air Pollutants and Emissions, Table A- Noncarcinogens. 3 - 8

Due to the lack of information provided in the DPEIS and to ensure compliance with the State of New Mexico's air ambient regulations, modeling may need to be conducted to show that the eight-hour average of the occupational exposure limit (OEL) and the required air toxic emissions limits listed under Section 502, Table A are not exceeded. If the OEL and /or the emissions limits exceed what is listed under Section 502, Table A, then an air quality permit must be obtained from the Department's Air Quality Bureau (AQB). For more information on the permitting and modeling requirements for toxic air pollutants, please refer to 20.2.72.400 NMAC.

It may be advisable to contact Mr. Lawrence Alires, Permit Engineer with the AQB, at 505-955-8020 prior to testing activities for permit verification.

There should be no long-term significant impacts to ambient air quality. 3 - 9

Public Comments 2006

DTRA/DPEIS
March 2, 2006
Page 5

We appreciate the opportunity to comment on this document. Please let us know if you have any questions.

Sincerely,

Ron Curry
Secretary

NMED File No. 2237ER

Public Comments 2006

State of New Mexico Department of Game and Fish

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Bill Richardson

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March 28, 2006

Defense Threat Reduction Agency
PEIS Public Comments
ATTN: BDQE
1680 Texas Street SE
Kirtland AFB, NM 87117-5669

Re: Draft Programmatic Environmental Impact Statement for Defense Threat Reduction Agency Activities on White Sands Missile Range
NMGF Doc. No. 10633

Dear Sirs:

The Department of Game and Fish (Department) has reviewed the Draft Programmatic Environmental Impacts Statement for Defense Threat Reduction Agency Activities on White Sands Missile Range (DPEIS). The proposed action (and preferred alternative) is comprised of nine activity-related categories: 1) collateral effects testing using stimulant materials; 2) rock penetration testing; 3) hard target lethality and defeat testing; 4) advanced weapons lethality testing; 5) static high explosives testing for target lethality; 6) weapons effects testing using the Large Blast/Thermal Simulator; 7) anti-terrorism testing; 8) development of weapon effects targets and test beds; and 9) improvements to the Permanent High Explosives Test Site (PHETS) Administrative Park.

The Department is primarily concerned with the potential effects of the exploded biological, chemical and radiological weapons simulant plumes on the State-Threatened White Sands Pupfish (*Cyprinodon tularosa*), which occurs in four locations in the Tularosa Basin on White Sands Missile Range and Holloman Air Force Base. On 30 January, 2002, we commented on a similar project for the Permanent High Explosive and Bedrock Penetration Test Sites Programmatic Environmental Assessment, where we voiced concerns about the potential affects of exploded simulant plumes on the White Sands Pupfish (WSP) and Desert Bighorn Sheep (*Ovis canadensis mexicana*). We have attached those comments for your reference. 4-1

Public Comments 2006

Defense Threat Reduction Agency 2 March 28, 2006

Regarding our similar, but heightened concerns for this proposed project, page 4-47 of Volume I states:

> The potential exists for simulant plumes from collateral effects test at the Capitol Canyon HTD test bed to drift through the air and settle out on the floor of the Tularosa Basin….A Hazard Prediction and Assessment Capability (HPAC) analysis was run to generate a plume model for a simulated Bg [*Bacillus subtilis* var. niger] release from the Capitol Peak HTD test bed…(Bg is used as a reasonable proxy for biological simulants in general). The model, using actual weather data for the region, showed Bg concentration and extent for three areas of known habitat for the White Sands pupfish downwind from the test bed (with approximate distances): Salt Creek 26 km (16 mi); Malpais Spring 16 km (10 mi); and Mound Spring 10 km (6 mi). The results indicated that surface deposition of Bg out of an airborne plume would be 1.0×10^{-11} kg/m^2 for all three locations, with diffusion to an even smaller concentration of 1.0×10^{-14} kg/m^2 over short distances from these locations…As indicated from the model run, the amount of Bg potentially entering these waters is exceedingly small. Bg would not have a significant effect on White Sands pupfish or other biota in the area.

4 - 2

A similar HPAC model was generated for a simulated dimethyl methylphosphonate (DMMP) release from the Capitol Peak HTD test bed using the same distances to White Sands pupfish (WSP) habitat, with essentially the same findings.

However, we believe that the modeling effort for Salt Creek is flawed, in that WSP occupied and "Essential" habitat occurs in the upper reaches of Salt Creek, approximately half the distance from the Capitol Peak HTD test bed to Mound Springs, as compared with the 16.0 miles modeled.

The Department is concerned about the potential for contamination of Salt Creek, the primary historic population of WSP by biological, chemical and radiological simulants' plume contamination of occupied habitat from aerosol deposition or by leaching through groundwater. 4 - 3

Page 4-40 of Volume I states, with regard to potential impacts on fish:

> The effects of the proposed CBR [chemical, biological and radiological simulant] test materials on fish and other aquatic organisms include toxic effects and the potential for bioaccumulation. Many chemical compounds, especially those with a hydrophobic component, partition easily into the lipids and lipid membranes of organisms and may bioaccumulate. If the compounds are not metabolized as fast as they are consumed, there can be significant magnification of potential toxicological effects up the food chain.

Many of the proposed chemical, biological and radiological weapons simulants are known to: 1) be toxic to fish, plants or insects which are prey items for WSP (e.g., *Bacillus thuringiensis* (Bt); Methyl salicylate (MES)); 2) have a high potential for bioaccumulation in fish and/or other aquatic organisms (e.g., Bis (2-ethylhexyl) hydrogen phosphate (Bis); Diethyl phthalate); 3) be a mutagen (an agent that increases the genetic mutation rate in organisms) or teratogenic (interferes with normal development of an embryo or fetus)(e.g., Cesium chloride (CsCl); Diethyl phthalate; Manganese dioxide (MnO_2)); or 4) have a high potential to leach into groundwater, creating a potential pathway over time to occupied White Sands pupfish habitat (e.g., Dimethyl methylphosphonate; Dowanol DPM glycol ether (DPM); Propionic acid; Triethyl phosphate (TEP)). 4 - 4

Public Comments 2006

Defense Threat Reduction Agency 3 March 28, 2006

None of these agents have been tested specifically for toxicity to the White Sands pupfish, many have not been tested for general fish toxicity using a proxy fish species, and the environmental fate of a significant number of these agents is unknown. 4 - 4 cont.

Therefore, the Department requests that before any testing of collateral effects using simulant materials are authorized, additional HPAC modeling be conducted using corrected distances for occupied WSP habitat in Salt Creek, and that other alternative be considered if the modeling indicates that testing could be detrimental to the Salt Creek WSP population. We also suggest that new modeling information be provided in a supplement to the DPEIS before the Final EIS is issued, allowing the Department sufficient time for review and meaningful comments on the findings to be considered by DTRA. 4 - 5

We appreciate the opportunity to comment on this project. Should you have any questions regarding our comments, please contact Mark Watson, Habitat Specialist, of my staff at (505) 476-8115, or <mark.watson@state.nm.us>.

Sincerely,

Lowell Ward for Lisa Kirkpatrick

Lisa Kirkpatrick, Chief
Conservation Services Division

LK/MLW

Attch: (1)

CC: Russ Holder (Acting Ecological Services Field Supervisor, USFWS)
Tod Stevenson (Deputy Director, NMGF)
Luke Shelby (Assistant Director, NMGF)
Chuck Hayes (Conservation Services Assistant Division Chief, NMGF)
Stephanie Carman (Endangered Fishes Biologist, NMGF)
Mark Watson (Conservation Services Habitat Specialist, NMGF)

Public Comments 2006

GOVERNOR
Gary E. Johnson

STATE OF NEW MEXICO

DEPARTMENT OF GAME & FISH

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January 31, 2002

Mr. Thomas A. Ladd
Director, Environment and Safety Directorate
Department of Army
U.S. Army White Sands Missile Range
100 Headquarters Avenue
Attn: CSTE-DTC-WS-ES
White Sands Missile Range, NM 88002-5000

Re: Permanent High Explosive and Bedrock Penetration Test Sites Programmatic Environmental Assessment, White Sands Missile Range
NMGF Doc. No. 7802

Dear Mr. Ladd:

The Department of Game and Fish (Department) has reviewed the Programmatic Environmental Assessment for the Permanent High Explosive and Bedrock Penetration Test Sites (PEA). During our 29 March 2001 scoping meeting at the Defense Threat Reduction Agency (DTRA) office at Kirtland Air Force Base, we voiced our concerns regarding the potential for these projects to impact state-listed desert bighorn sheep (*Ovis canadensis mexicana*) and White Sands pupfish (*Cyprinodon tularosa*). We are concerned primarily with the potential for impacts from 1) mining operations and bombing on desert bighorn sheep in the San Andres Mountains from the Bedrock Penetration tests; and 2) biological and chemical warfare agent simulant tests on White Sands pupfish.

DTRA proposes to test 30+ biological and chemical warfare agent simulants within 15 miles of known occupied pupfish habitat. Plumes from previous tests have been known to travel up to 30 miles. Therefore, we requested in our 11 April 2001 comments on the draft PEA that the PEA contain 1) a thorough analysis of the potential effects of these agents to aquatic biota in general and White Sands pupfish in particular; 2) Material Safety Data Sheets (MSDSs) for each agent; 3) a record of plume tests at PHETS; and 4) an opportunity to visit the test sites.

Although we have not been afforded the opportunity to visit the test sites, the Department does appreciate the inclusion of the information we requested in the PEA. This information allows the reader a greater opportunity to evaluate the potential effects of these simulants and explosives on the surrounding biota. After review of the PEA, we agree that it is unlikely that plume simulants will be deposited in pupfish habitat, but also note that several of the simulants (TEP, Bt, and Bg) have been experimentally determined to be lethal to fish at dosages from 100 mg/l to 400 mg/l. We request that the surface water quality

Public Comments 2006

Mr. Thomas A. Ladd 2 January 31, 2002

monitoring plan for White Sands pupfish habitats agreed to by WSMR in the recently signed Integrated Natural Resource Management Plan will monitor for simulants and residual explosives chemicals, if possible.

Although the minutes from the scoping meeting printed in the PEA states that NMGF wants to be notified in case of an accident to pupfish habitat from these projects, we would like to clarify that within the White Sands Pupfish Cooperative Agreement, WSMR has committed to notifying signatory agencies in the event of an accident.

We appreciate the opportunity to comment on these projects. Should you have any questions regarding our comments, please contact Mark Watson, Habitat Specialist of my staff at 476-8115, or mwatson@state.nm.us.

Sincerely,

Tod W. Stevenson

Tod W. Stevenson
Chief, Conservation Services Division

TWS/MLW

Cc: Scott Brown (Assistant Director, NMGF)
Bill Hays (Conservation Services Assistant Chief, NMGF)
David Propst (Endangered Fishes Biologist, NMGF)
Nic Medley (Conservation Services Aquatic Habitat Specialist, NMGF)
Pat Mathis (Southwest Area Habitat Specialist, NMGF)
Alise Goldstein (Bighorn Sheep Biologist, NMGF)
Mark Watson (Conservation Services Habitat Specialist, NMGF)

Public Comments 2006
Private Individuals/Organizations

1 Camino Tres Ritos
Placitas, NM 87043
March 21, 2006

Defense Threat Reduction Agency
PEIS Public Comments
ATTN: BDQE
1680 Texas St. SE
Kirkland Air Force Base, NM 87117-5669

Re: Response to PEIS Draft EIS for DTRA Activities on White Sands Missile Range, NM

To Whom It May Concern:

We appreciate that DTRA in this Draft made an attempt to answer at least some the issues we brought up in our letter of September 9, 2003, in particular our concerns about possible effects of this testing under Alternative I on the seismic proclivities of the area. However, your researchers seemed to miss our point, i.e., that the potential for leakage of chemicals into the groundwater and seepage through rock layers into deep, far-reaching fissures in the surrounding areas can act as triggers for future earthquakes. The Draft makes a number of categorical statements, such as "Earthquakes in the Socorro area are unrelated to the fault zones within the WSMR." Based upon references and information we submitted, together with the enclosed chart, we believe such a statement is entirely suppositional. 5-1

DTRA in this Draft attempts to obfuscate such a consequence by selecting a very narrow definition of earthquakes and stating that they are "caused by large earth movements". (As are mudslides!) Yet in the Rocky Flats, CO earthquake incident, as well as several others, earthquakes are acknowledged to have occurred in correlation to seepage of chemical wastes into groundwater and eventually to magma, triggering severe quakes. (Stephen M. Younger, DTRA Director at Ft. Belvoir, VA, in a letter dated Jan. 16, 2004 to NM Sen. Jeff Bingaman, states "DTRA agrees that high-pressure injection of wastewater into fractured basement rock could cause seismic activity."). 5-2

Since such seepage can follow fissures for great lengths and at varying depths, we question the certitude of the assumption that bedrock would shield the magma from chemical and water seepage after depth-testing of explosives at this site. The magma core underlying the cluster of 36 earthquakes, referred to as the Socorro Seismic Anomaly, has a minimum lateral extent of 3400km2 and extends for great distances through the Rio Grande Valley rift area and beyond and has exhibited slip-strike movements.

As to the assertion that "historically" there has been no earthquake activity in the vicinity of DTRA's depth testing, we refer you to the enclosed chart showing the historic seismic activity in the entire Socorro area extending past San Antonio NM specifically, as well as the entire surrounding area. 5-3

Public Comments 2006

The magnitude of all this seismic activity is relatively unimportant, since historically, the amount of explosive depth testing you plan to use (i.e., 500-ton TNT, etc.) under Alternative I has never before been attempted, to our knowledge, in the areas you plan to use for depth testing. It would therefore appear that -- just as your Draft frequently makes use of the term "historic" in this context (and as the term "not expected "is applied when referring to the consequences of chemical toxicity), this statement has little background in fact and is the result assumptions. 5-4

Further, since tidal moon action is frequently a precursor of seismic activity, will a potential confluence of such tidal action and chemical seepage into the existing underlying magma, be a dual trigger? We suggest that you step away from your narrow earthquake definition to include "potential causal events." 5-5

Will DTRA or the United States government assume fiscal liability and moral responsibility toward the citizens of the outlying areas? As previously noted in our attached 9/9/03 letter, this has not been the case in recent events of toxic chemical drift and explosive property destruction in this area by your agency. Your PEIS Draft did not address this complaint at all. We therefore re-submit our letter of 9/09/03 for re-consideration, along with this one. 5-6

DTRA appears anxious to bury all issues with pat evasions in this as well as in other areas. With the health, welfare and safety of US citizens of the Socorro/San Antonio area at stake, we are disappointed in your approach, and hope a more serious investigation will come forward. We do not accept your conclusion that the third alternative of "moving WSMR elsewhere" had to be dropped because of "lack of space" elsewhere. We are fully aware that the US government possesses virtually uncounted acres of land far from human populations. Perhaps the EIS should address the possibility of protecting the lives of US citizens by embracing that dismissed third alternative, and moving this testing to an area uninhabited by human beings and vulnerable creatures. 5-7

The City of Albuquerque is now facing the onslaught of the toxic pollution of its water supply due to long-term seepage from Sandia National Laboratories' "Mixed-Waste Landfill" (1959 to 1988). Sandia Labs is now being sued and we expect that, after these proposed tests have faded into infamy, DTRA will be held responsible for the harm it is now doing and attempting to do locally to our people and to New Mexico's environment. 5-8

Yours truly,

Elizabeth Hillerstrom

ELIZABETH HILLERSTROM

TORD HILLERSTROM

Public Comments 2006

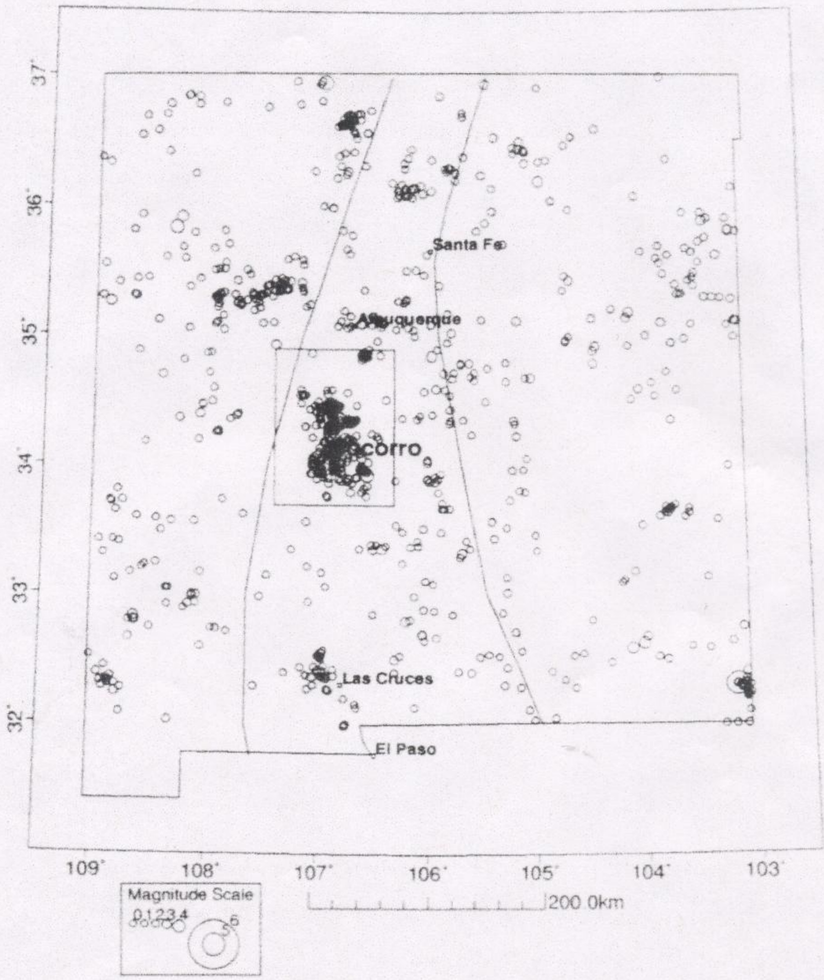

Figure 1.1. New Mexico seismicity $M_d > 1.3$. Note the concentration of activity near Socorro and the aseismic halo surrounding it. The events were recorded at New Mexico Tech from January 1962 through December 1995. A generalized outline of the Rio Grande rift (after *Chapin* [1971]) occupies the center of the state and the study area is restricted to the Socorro Seismic Anomaly [*Sanford et al.*, 1995[1]] (boxed region).

36

Public Comments 2006

COPY
RE-SUBMITTED

418 Bosquecito Road
San Antonio, NM 87832
September 9, 2003

Defense Threat Reduction Agency, Public Comments
ATTN: TDTS,
1680 Texas Street SE
Kirtland Air Force Base, NM 87117-5669

Re: Comments in re DPEIS for White Sands Missile Range, NM

To Whom It May Concern:

We live in an area virtually contiguous to the border of the Missile Testing Area, four miles north of highway 380. We estimate we are not more than 17 miles from the proposed testing areas. We wish to state our opposition to either continued or expanded testing at White Sands Missile Base for the following reasons:

1) SEISMIC ACTIVITY: A 1400 KM long earthquake fracture zone (extending from southwestern Arizona through New Mexico, across the Texas Panhandle into Oklahoma) runs along the Rio Grande River through Socorro and to The Bosque del Apache National Wildlife Preserve, where it veers northeastward. A large body of magma sits beneath Socorro at varying depths. New Mexico Technical Institute already conducts weapons tests in a mountain at the northwest of the Socorro portion of the fracture zone; numerous seismic events have persisted over the years in this area, with large earthquake swarms occurring during the 1980s. It is known that high pressure injection of chemical waste water into fractured basement rock at the Rocky Mt. Arsenal correlated with 7.0 earthquakes both in the Denver, CO area and oil fields in West Texas. A NM Tech study stated "possible explanation for the periodic bursts of seismicity in the (Socorro area) swarms could be irregular injections of fluid into the crust"*...and **"spasmatic movements of magma or water in the seismogenic crust could be the potential driving force behind the bursts of seismicity."****

   U.S. government "bunker-busting" weapons using "non-radioactive cessium" and other "simulants" equivalent to the force of nuclear weapons, deep in tunnels in this area dangerously near the active fault zone, MUST BE INVESTIGATED in terms of their potential effects upon the existing and widespread seismic activity in this area. The uncertainty as to what triggers local seismic activity should be sufficient cause for the immediate cessation of ALL testing in this area.

2) CHEMICAL TOXICITY: In the two years since we have lived in our present home, we have on several occasions been subjected to acrid, sickening odors wafting over our property (and that of other property-owners several miles away), lasting for an entire night and into the next morning. We are now convinced that these odors arose from testing already being conducted at this testing site, and we therefore object to the use of any test chemicals. Circular wind patterns in New Mexico are frequently unpredictable, with abrupt wind changes—as the U.S. Forest Service discovered in the recent fire that could have destroyed the Los Alamos Lab. THE PROPOSED "MONITORS" CANNOT PREDICT, NOR CAN THEY PROVIDE AFTER-THE FACT PROTECTION, IN THE EVENT OF SUCH UNPREDICTABLE WIND CHANGES. With such testing as is proposed, the U.S. government suggests that citizens agree to participate in a game of roulette using these experiments as gunshot.

   In addition to the possibility for human exposure, there are other unquantified threats to the environment, i.e., groundwater contamination affecting sensitive and endangered fish and bird

Public Comments 2006

populations (willow flycatchers, silvery minnow, etc.) The groundwater in the Rio Grande and surrounding area is generally just a few feet below surface. Contaminants will be carried on river water and through rainwater run-off, and infused into the soil and inevitably, the groundwater.

3) COLLATERAL DAMAGE: We have been informed by a neighbor that a large front picture window in her home sustained a large crack and required replacement – for no discernible reason. She attempted to obtain compensation from White Sands, but, after hours of being shifted from one command to another, was informed that White Sands was "not responsible" for such damage. We have recently determined that the INNER glass layer of TWO SKYLIGHT WINDOWS in our home is both cracked and broken – again for no discernible reason (there have been no supersonic flights in our area – only transports and Blackhawk refuelers).

4) CULTURAL AND HISTORICAL: The nearby Trinity Site itself -- as well as the soil for miles around the area -- were contaminated by nuclear fallout for years after the first nuclear bomb tests there. The proposed expansion to accommodate renewed nuclear testing is a terrifying reminder that the U.S. government once subjected its unsuspecting citizens to the most dangerous experimental weapons test ever conducted anywhere prior to that time. The Trinity Site continues to warn American citizens of the danger that can be imposed upon them by a thoughtless, unconcerned government. If anyone could excuse such use of governmental authority during WWII, there is certainly no such justification for it at this time.

THE WEAPONS PROPOSED FOR THIS TESTING ARE OFFENSIVE, NOT DEFENSIVE, WEAPONS. Why, therefore, is THIS agency – The Defense Threat Reduction Agency -- putting forth these offensive-weapons proposals? Is not this testing illegal under our non-nuclear proliferation treaties with other countries?

WE CAN ACCEPT NO MITIGATION OR ALTERNATIVE FOR THE TESTING OF SUCH POWERFUL AND OFFENSIVE WAR WEAPONS -- WITH SEISMIC DRIVING FORCE POTENTIAL AND USING QUESTIONABLE CHEMICALS -- IN SUCH CLOSE VICINITY OF HUMAN BEINGS AND ENDANGERED SPECIES.

We therefore respectfully urge that this EIS recommend—not only that these tests NOT be conducted—but that White Sands Missile Base REMOVE the existing structures and close down this portion of its weapons testing area permanently.

Yours truly,

Elizabeth Hillerstrom

ELIZABETH HILLERSTROM TORD HILLERSTROM

* "Earthquake Swarm Studies in the Central Rio Grande Rift: Specific and General Results," by Robert S. Balch, NM Institute of Mining and Technology, Socorro, NM 87801 April 1997, p.122

**Ibid..

Public Comments 2006

outbind://365-00000000930F824B95C...

From: Steve Harrington [sharrington@gmail.com]
Sent: Monday, March 27, 2006 10:59 PM
To: WSMR_PEIS_Comments
Subject: WMSR PEIS public comments

Dear Sirs/Madams,

As a person with a background in science and technology, I strongly oppose the proposed increase in testing by the Defense Threat Reduction Agency (DTRA) at White Sands Missile Range (WSMR). I took the time to read the entire 600+ pages of the draft Programmatic Environmental Impact Statement (PEIS) cover to cover, including both the main body and the appendices. Despite a clear attempt by the report's authors and/or editors to make the case that expanded testing is both justified and safe, what I found in the report raises many serious questions. Because the report is quite lengthy, it is a somewhat overwhelming job to critique it in its entirety. I will hit some of the more troubling spots, but the problems noted herein are by □no means a comprehensive list of the shortcomings of the report. 6 - 1

The PEIS report, while presented in a very scientific manner, is actually full of undocumented or partially documented suppositions. In fact, I did a word and phrase count using the Adobe Acrobat Reader software, and found the phrase "is not expected" (e.g. some substance or action "is not expected" to harm the environment) used 93 times; similarly, the phrase "is expected" is used 111 times in the report, the phrase "is not likely" is used 21 times, and the word "unlikely" also makes a strong showing with 46 occurrences. Many of these phrases are used with limited supporting evidence, supporting evidence cited out of context, or evidence that is only marginally related to the action being proposed.

For example, while the report claims that the environmental impacts (of the proposed testing option) on avian and mammalian wildlife would be negligible, the same report admits that "the effects of exposure of the proposed chemicals on avian wildlife is unknown" (page 4-39 of the report), and "the effect of exposure of the proposed test materials on mammalian wildlife is largely unknown" (page 4-37). On page 4-35, the report notes that "the effects of chemical, biological, and radiological simulants and other test materials on native faunal species are largely unknown." 6 - 2

As another example, the report argues that the bio-simulant Bg (Bacillus Subtilus) is "generally not pathogenic to humans", but goes on to note that "in rare cases Bg has been associated with livestock abortion and crop disease" (page 4-35). Do we really need to be testing with items known to be associated with livestock abortion and crop disease? I would suggest not. The report also notes that repeated use of Bg may affect beetles and moths, affect the reproductive ability of plants, and affect animals which are insectivores (i.e. that feed on beetles, moths, and other affected insects).

Yet another example of the report attempting to downplay risks is found on page 4-28 of the report, where the authors note "the effects of DMMP on plants is not known" but conclude (apparently on faith) that it "is not expected to significantly affect flora." If the effects of DMMP on plants are not known, I really do not care what the DTRA "expects." Science is not based on 6 - 3

4/5/2006

Public Comments 2006

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expectations or feelings, but on hard empirical data. The report itself states that the effects on plants is not known. This appears to be a clear example of faith-based science, which is in fact not science, but advocacy or lobbying. 6 - 3 cont.

The DTRA suggests that a non-infectious influenza-A virus be used as a bio-simulant, simulating more dangerous biological agents. The report correctly notes that a dead virus strain would be non-infectious. Nowhere in the report, however, does it address the question of what happens if a live virus is mistakenly used. In fact, the entire report reads as if mistakes and errors are not possible, thus never asking questions such as "what happens if something goes wrong or our predictions aren't accurate" or "what happens if the science is wrong on this"? We all know of many cases where a substance was deemed safe for years, only for the scientific community to later realize otherwise. We need look no further than the history of nuclear weapons testing, where our government - *possibly* as an honest mistake based on the science available at the time - exposed many in our country to dangerous levels of radiation. Similarly, there are numerous cases of species being introduced, for benign or beneficial purposes, into an area in which they were not native only to later have the introduced species take over and wreak havoc on the environment. Introducing live bacteria, (hopefully) dead viruses, and so forth, is really banking on perfect science and perfect test implementations, with mistakes or human errors not allowed for in the report or the analysis. This seems dangerously short sighted. 6 - 4

Among the more puzzling contradictions, of which there are many, in the DTRA proposal is DTRA's position on computer modeling as an alternative to real-world testing. In several places, the DTRA argues that while computer models are useful, they are not sufficient and cannot be used as replacements for real-world tests (page S-5, page 2-24, etc.). However, having made the argument against computer modeling, the report then goes on in self-contradictory fashion by using computer models (for example, models of plumes of chemicals and their dispersal into the atmosphere, computer models of water runoff, and so forth) as support for the idea that materials will not adversely affect the environment (e.g. page 4-67). Page 4-58 of the report recommends creating predictive models (i.e. computer models) to "ensure hazardous quantities of test materials do not exit the range." It seems the DTRA wants to use computer models as "hard" evidence when it's convenient to them, while at the same time arguing that they cannot be trusted as replacements for actual tests. Either computer models are sufficient or they are not, but they obviously cannot be both at the same time. 6 - 5

The DTRA's proposed expansion of testing at White Sands Missile Range would involve the dispersal of literally hundreds of chemical or biological agents into the environment and atmosphere. While the report attempts to list all of these agents with any known dangers noted, the report itself admits that "in-depth information is not available for each chemical" and furthermore says "concentrations at which other simulants produce phytotoxicity are not well studied" (page 4-29). As the report notes, if the DTRA's proposed option is granted, it is expected that simulants in the air will escape White Sands Missile Range boundaries - an admission that the DTRA cannot strictly constrain the chemical and biological agents' dispersal. 6 - 6

It is also very troubling that for each chemical, the DTRA's proposed option would allow up to 16 tests with each test dispersing up to 4,000 pounds of the chemical, for a total of *64,000 pounds per test material*. With hundreds of test materials proposed for use, this is literally hundreds of thousands (if not millions) of pounds of chemicals that are proposed for release in the missile range, with much of the science incomplete.

4/5/2006

Public Comments 2006

While the environmental problems are my primary concern with the proposed option (of expanded DTRA testing at WSMR) - and while I could go on for many pages citing additional problems or contradictions in the report - I would like to point out one problem that is not environmental in nature, but which I believe illustrates the lengths to which the report's authors will go to bend the truth to meet their desired goals. On pages 2-19 to 2-22 of the PEIS, the report notes that an agreement between WSMR and New Mexico's State Historic Preservation Office (SHPO) prohibits building any new permanent structures on the area comprising the Trinity National Historic Landmark. Yet, the proposal by the DTRA suggests building permanent structures in violation of this agreement: "DTRA proposes to upgrade the PHETS Administrative Park by replacing the trailers/temporary structures with energy efficient pre-engineered buildings placed on concrete slabs. These pre-engineered buildings and concrete slabs are temporary structures that would be dismantled and removed when no longer needed" (page 2-22). This is probably the most egregious example of Orwellian government double-speak in the report.

6 - 7

Using DTRA's absurd definition, no building of any kind is a permanent structure because any building can be torn down. This is clearly an intentional misreading of the intent of the agreement between WSMR and New Mexico's SHPO, with DTRA proposing a willful violation of the agreement with both malice and forethought. Clearly, any reasonable person would admit that a structure with a concrete slab is, in fact, a permanent building. No amount of government double-speak can change that fact. That DTRA would even attempt to make a preposterous claim like this illustrates in a clear and concise way the lengths to which they will go to lobby for the expanded testing, i.e. the "proposed option". It seems that facts, environmental concerns, and agreements are of little import to those who want to increase DTRA testing and that they believe that a little "spin" can make anything seem reasonable to the public. Suffice it to say, nothing could be further from the truth; the public is simply not that gullible.

As I said, I could go on for many, many, many pages citing additional defects in the PEIS draft for DTRA's proposed testing at WSMR. However, the intent of my letter is not to make an exhaustive list of the PEIS draft's shortcomings. Rather, I want to publicly document the bias and agenda of the PEIS report's authors and/or editors. The report has a clear agenda. This agenda may be wrapped in a package that appears to be science-based, but the report's facade of scientific rigor quickly unravels with even the slightest critical analysis. In summary, I urge you in the strongest terms possible to choose the "no action" option and to reject the flawed environmental impact analysis of the DTRA's "proposed" option for expanded testing at WSMR. 6 - 8

Sincerely,

Steve Harrington
510 Carmen Place
Socorro, NM 87801

Public Comments 2006

From: Kathy Albrecht [lapaz@zianet.com]
Sent: Tuesday, March 28, 2006 11:59 PM
To: WSMR_PEIS_Comments
Subject: public comment

I intend for these comments to be included in their entirety in the Final DTRA White Sands PEIS. They are submitted on March 28, 2006, the date "comments will be accepted until." I protest that my Scoping comments and those of others were not printed in the Draft PEIS and I believe the reason is found on page S-5: "The elimination of DoD development and testing of weapons to reduce the threat of WMD was suggested at a public information meeting ... This alternative is a national policy issue beyond the scope of the PEIS [&] Therefore ... was excluded from further consideration." 7 - 1

An EIS process is driven by the NATIONAL Environmental POLICY Act.
How disturbing that Americans' concerns that the premier testing ground of the U.S. arsenal threatens not only the environs of WSMR, but additionally the nation's and global environmental health by exacerbating warfaring tensions worldwide, be deemed "beyond the scope" of making a decision to expand weapons testing. I live scarcely 13 miles from the Large Blast/Thermal Simulator; mine and other disarmament advocates' comments will NOT be "excluded from further consideration," lest you invite litigation.

First, I take issue with the bias reflected throughout the DPEIS, that the No Action alternative would "reduce the Department of Defense capability to control and eliminate weapons of mass destruction" and that DTRA assists "in safeguarding the United States and its allies from weapons of mass destruction" or counters "proliferation of WMD." Few thoughtful, informed world citizens today believe that over-armed America has "a need to improve weapon systems designed to defeat enemy military assets" (S-2). And isn't The Pot (with our ready nuclear arsenal) calling The Kettle 'black'
to warn that such enemies might "house WMD and pose a significant threat to international stability and peaceful coexistence"?

WE are the state which has refused to honor our treaties and the world's chief tribunal and accomplish nuclear disarmament, thus goading reluctant states into proliferation. We possess, many times over, the most massive conventional firepower on earth and we now blast away annually at civilians around the globe, often from 35,000 feet, whenever we're so moved. Don't try to tell the public that expanding northwest White Sands explosive testing activities will engender planetary peace nor make Americans more secure. All these proposed activities will do is soak up a hefty clump of obscene $500 billion to $1 trillion annual Pentagon budgets for a decade, line the pockets of arms developers' stockholders and further drive the forces who would deny the U.S. vicious world domination to more and more desperate acts of resistance. 7 - 2

Both DTRA's WSMR activities and those desperate acts, my friends, comprise horrendous potential environmental threats to this nation.
And I, as a citizen and test-site neighbor, have the obligation and the privilege to point that fact out during this EIS preparation!
Don't you dare exclude Disarmament (let alone No Action) "from further consideration" -- ever! It is undoubtedly our only hope. I challenge each of you well-meaning preparers and decision-makers to recommit your life's work to dismantling this military beast. Or at least to stop feeding it.

Meanwhile, "lethality and defeat testing," "advanced weapons lethality," "high explosives target lethality" ought not to be pursued where 17 rare and threatened plant species native to New
Mexico and to White Sands are thus endangered.(C1-5) The two
Bacillus simulants ought not to be excused as common soil bacteria and released to threaten precious moths who serve that ecosystem by pollinating flora. (... "simulants may cause plant mortality, impair plant growth, or reduce plant reproductive success" S-9)
Numerous greenhouse gases resulting from WSMR explosions ought not to be released into a climatological situation already on-the-ropes. 100 chemical compounds released in DTRA testing are deemed Hazardous.
And how grimly ironic that a full 24 mammalian, avian, reptilian and aquatic species which

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Public Comments 2006

are either Endangered or Threatened attempt to take refuge amidst the toxins generated by the Missile Range! Stop this madness.

Sincerely,

Kathryn Albrecht
San Antonio, New Mexico

--

If we are facing in the right direction, all we have to do is keep walking.
-- Buddhist proverb

2

Public Comments 2006

From: Dave Wunker [dewunker@yahoo.com]
Sent: Saturday, March 18, 2006 6:01 PM
To: WSMR_PEIS_Comments
Subject: comment on the WSMR PEIS for DTRA testing

I oppose any expanded testing of biological or chemical simulants by the DTRA at White Sands Missile Range. I am amazed at the amounts of such materials that are being considered for release into the atmosphere. Many of these are toxic to plants and animals at some level. The effects of others are unknown.

Why do we as a society continue to play Russian roulette with chemicals when we are plagued with various cancers, most of which probably have an environmental origin? I have had one sister die of cancer (probably colon cancer to start) and another requiring a mastectomy because of breast cancer.

Now we are also going to play around with bacterial agents, when various bacterial infections we thought we had under control are on the rise (like tuberculosis), and our immune systems are becoming compromised. 8 - 1

Efforts need to be concentrated on preventing and addressing conflict before it reaches the stage when someone or some country is willing to use bacteriological or chemical weapons.

Testing of real conflict sistuations should be confined to computer modeling or if field testing seems absolutely necessary, then only materials known to be non-toxic to all living things should be used.

I strongly support the "no action" alternative.

Sincerely,

David Wunker
PO Box 36
San Antonio, NM 87832

Public Comments 2006

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Public Hearing Comments on the
D raft Programmatic Environmental Impact Statement for DTRA Activities on
White Sands Missile Range, New Mexico

(PLEASE PRINT)

Name: Julie A. Walter

Organization/Affiliation: Student

Address: 328 School of Mines Rd. Socorro, NM

Phone (optional)

Email address (optional): jeilers@nmt.edu

Julie A. Walter

Comments:

My comments are in response to the oral comments made by the first woman who commented during the oral comment session of your public review in Socorro. First of all, I want to say that I think your program is an excellent way to help protect Americans and the American public from future disasters like that of September 11. A comment was made about several corporations (Ratheon, Lockheed Martin, GE, etc) bringing in huge profits to develop weapons of mass destruction for the United States Military. This is a blatant mis-statement, while many of these companies do fulfill contracts for the US military, they do not actually develop the weapons of mass destruction that I understand are to be simulated at this test facility.

Another comment that I would like to respond to is the comment that was made about having to retrain the youth of America to work with these weapons every time a new weapon/technology is developed. It is my understanding that this test facility is using materials that simulate that impact of these weapons of mass destruction, not the actual thing. Also this testing is not to be done by the youth of America, but by trained professionals. Finally, I don't really see this being a problem as many, if not all nuclear warheads are not fired by people who stand right next to them like a cannon, but are fired remotely, and can be fired from clear across the world, which does not pose any threat to our youth, as was expressed in the oral comment session. 9-1

In conclusion, I feel that DTRA's proposed program is an excellent way for the US military and government to find the most efficient way to respond to an attack on a large scale should such an attack occur. One of the major complaints of the government today was the lack of early/quick response to both hurricanes Katrina and Rita. I think that this testing program is an excellent response of the government to be able to have a more timely response to such things that would endanger much more than one region of the country. White Sands Missile Range and DTRA's testing plan is the best way for the United States to prepare itself for any future attack on our people and our way of life and allows the government to develop the most effective way to deal with any such attack.

Public Comments 2006

Public Hearing Comments on the
Draft Programmatic Environmental Impact Statement for DTRA Activities on
White Sands Missile Range, New Mexico

(PLEASE PRINT)

Name: Kendrick Walter

Organization/Affiliation: Student

Address: 328 School of Mines

Phone (optional)

Email Address (optional)

Comments:

I would like to comment of some of the comments that were made by the first lady to speak during the oral session at the Macey Center in Socorro, New Mexico. She made a comment on how the youth of America couldn't keep up with the chemical and biological strategies that are currently being used. As a student, I have noticed that the future of warfare will more than likely be some sort of chemical or biological weapons. I feel that some of her comments are not accurate. I feel that the DTRA has proposed a new plan that will ultimately help American citizens if another terrorist attack were to take place. 10 - 1

One of the biggest complaints of the Katrina Hurricane disaster was how quickly Government agencies responded to those in need. I feel that the DTRA is trying to improve how we respond to an unexpected attack. Even though Katrina wasn't a terrorist attack we still can learn from it. If we know how biological and chemical warheads work we can quickly respond to an attack, which may save millions of lives. To conclude, I feel that the DTRA has proposed an excellent plan to open a new testing site.

Kendrick Walter

Public Hearing Transcripts 2006

Public Hearing Transcripts 28 February, 2006 – Alamogordo, New Mexico

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STATE OF NEW MEXICO)
) ss
COUNTY OF OTERO)

A F F I D A V I T

I, JAN WIMBERLY, Certified Court Reporter, Alamogordo, New Mexico, do hereby state:

The Draft Programmatic Environmental Impact Statement (PEIS) for DTRA Activities on White Sands Missile Range, New Mexico Public Hearing was duly noticed and scheduled for February 28, 2006, from 6:30 until 8:30 p.m., at the Alamogordo Civic Center, 800 East First Street, Alamogordo, New Mexico.

At 7:00 p.m, Mr. Jeffrey Thomas gave the complete presentation which was to be given to the public. It should be noted for the record, however, that no member of the general public was present in the audience and no comments were made.

GIVEN UNDER MY HAND AND SEAL OF OFFICE, this 7th day of March, 2006.

JAN WIMBERLY, CCR NO. 13
LICENSE EXPIRES: 12/31/06

DAMA'S REPORTING SERVICE
P.O. Box 2022, Alamogordo, New Mexico 88311

Public Hearing Transcripts 2006

JAN WIMBERLY

P.O. Box 2022
Alamogordo, NM 88310
Phone (505)434-1822
Fax (505)434-5025
janw@netmdc.com

March 10, 2006

Newtec
P.O. Box 426
WSMR, NM 88002

Re: PEIS Hearing, 2/28/06

To Whom It May Concern::

Please find enclosed an affidavit I have prepared regarding the PEIS hearing that to be held in Alamogordo on 2/28/06. As noted in the affidavit, no citizens were in attendance at the meeting, and thus, no public comments were made. I have not prepared a transcript because there was none prepared. Mr. Thomas gave a "dry run" presentation and did not want me to transcribe it.

I have enclosed my bill for two hours of appearance fee at the agreed-upon rate of $40 per hour, plus applicable sales tax.

Sincerely,

Jan Wimberly

RECEIVED
MAR 15 2006
BY:

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MAR 13 2006
New Tec
HUMAN RESOURCES OFFICE

Public Hearing Transcripts 2006

Public Hearing Transcripts 1 March 2006 – Las Cruces, New Mexico

1

DEFENSE THREAT REDUCTION AGENCY
PUBLIC AFFAIRS

WHITE SANDS MISSILE RANGE
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT
PUBLIC MEETING

TRANSCRIPT OF PROCEEDINGS

6:30 p.m. MST
Wednesday, March 1, 2006
Ramada Palms
201 E. University Avenue
Las Cruces, New Mexico

Reported by:
Breck C. Record, CSR
TX CSR 2406
Expires 12-31-06

COPY

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19:00 MS. CHERI ABDELNOUR: Good evening.
We're here tonight to receive your comments on the Draft
Programmatic Environmental Impact Statement for DTRA,
Defense Threat Reduction Agency, activities on White
19:00 Sands Missile Range.
I'd like to introduce our hearing
official, Mr. Jeffrey Thomas.
MR. JEFF THOMAS: Thanks. Everybody hear
me okay?
19:00 I have a little bit of notes here, but
I'm not gonna go behind the podium and I'm too short
anyway and you won't be able to see me.
Thanks for taking time to attend this
public hearing. My name is Jeff Thomas and I'm the
19:00 Director of Tests for the Defense Threat Reduction
Agency and I'm located in Albuquerque, New Mexico, and I
am the hearing officer for this session. I want to
personally thank you for taking the time to come here.
This is an important process. And the
19:01 openness of what we're doing in our draft programmatic
EIS document and the time to get public comments and to
put it into the final drafts is very, very important.
And we do have copies of the draft Programmatic
Environmental Impact Statement available if any of you
19:01 want to grab it and take a look at it, and please take a

Public Hearing Transcripts 2006

19:01 copy, if you wish.

Okay. What I'm gonna cover is some of the ground rules for tonight. A brief overview of the National Environmental Policy Act or the NEPA process.
19:02 Specifically, how the Programmatic Environmental Impact Statement and the purose of that, how that fits into the National Environmental Policy Act. Our Defense Threat Reduction Agency's role in this process and what we'd like out of the public and that is involvement and
19:02 input.

Again, I'll go over some of the ground rules on how we can do this public hearing, but, primarily, we want to receive your comments and we want to incorporate those comments as part of the public
19:02 record to put into the Programmatic Environmental Impact Statement draft, and then we'll go ahead and adjourn the session.

The National Environmental Policy Act really establishes a framework for protecting the
19:02 environment. And for this Programmatic EIS, what we want to do is to have an environmental review process to help us. And we want to help us make those informed decisions based on the environmental consequences of our activities and what we are currently doing now and we
19:03 propose to do at the White Sands Missile Range. And our

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19:03 primary focus through this process is to take actions to protect, restore and to enhance the environment at White Sands Missile Range.

19:03 What is our defense reduction agency role in the National Environmental Policy Act process? Well, we are the lead federal agency in developing this Programmatic Environmental Impact Statement. We are partnering very, very closely, obviously, with White Sands Missile Range and they are designated as the

19:03 cooperating agency for this Programmatic Environmental Impact Statement.

What I'd like to do is go over a little bit of the ground rules. If anybody wants to have a presentation tonight, what I'd like them to do is to

19:04 register that you want to make a presentation and then what I will do is I will call you up to make that presentation. Otherwise, at any time during this review process, you can mail the comments that you have regarding the draft Programmatic Impact Statement to

19:04 that address. Defense Threat Reduction Agency. It's an organization BDQE at Texas at Kirtland Air Force Base. Or you can fax it to that phone number there or e-mail it to that e-mail address. And, again, the whole purpose of this process is to get your input and solicit

19:04 that input at any time.

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19:04 For this opportunity for the public to provide comments in the form of oral comments, again, what I'd like to do is to make sure that those who want to make those oral comments sign up as a speaker at the
19:05 registration table. Now, what I'd like to do is to make sure that we give ample opportunity for those speakers to be heard, therefore, approximately 10 minutes or so, and we'll have a timekeeper to make sure that we follow those timing criteria. But please remember that besides
19:05 just the oral comments in this particular public session here, we will accept written comments at any time. And, again, I mentioned the slide before where you can provide those comments. And what's important is that we want those comments by March 28th so that we can
19:05 incorporate them into the revised draft of the Programmatic Environmental Impact Statement document. So, the earlier that we get those inputs, the more time will allow us to put those into revised versions of that document.

19:06 If you -- if you have any questions at any time during this review period, not just this public session, but the review period for the Programmatic EIS, again, go to any of those website locations, call us at Defense Threat Reduction Agency, Public Affairs. What
19:06 we're really trying to do here is get input to make this

Public Hearing Transcripts 2006

19:06 a better document. And we can only do that by getting input. So, if you have any questions on maybe how to provide the input, here's how you can get ahold of us for that. And again these were the numbers that I
19:06 showed before, either in an address and phone number or in an e-mail address.

Okay. What I'd like to do now is open it up if there's anybody who wants to present an oral presentation.

19:07 *(No response.)*

MR. JEFF THOMAS: What we will do then is remain here until the 8:30 time period in case people come in and want to do that. And as you know, for the first couple of hours, we had boards up there and a lot
19:07 of Defense Threat Reduction Agency and White Sands Missile Range officials here to answer any questions that anybody may have and we will continue to have that available throughout the evening. And with that we'll just stay around in case people do show up and want to
19:07 make a public comment, any sort of questions or comments anybody may have.

Okay. We will be available. We will be here. And thank you for coming. I appreciate it. Let me go back to an earlier slide so that, again, if you
19:08 want to write down any sort of numbers, if you have any

Public Hearing Transcripts 2006

19:08 questions, comments, obviously I'll just leave this up.
But I'm available, we're all available for this evening.

(Hearing adjourned from 7:08 to 8:30 with no public comments.)

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CERTIFICATE

I, Breck C. Record, Certified Shorthand Reporter in and for the State of Texas, do hereby certify that the above and foregoing contains a true and correct record, produced to the best of my ability via machine shorthand and computer-aided transcription, of the proceedings had in this matter.

Certified to on March 9, 2006.

Breck C. Record
Certificate No. 2406
Expires 12-31-2006
Firm No. 114
(49440)

Public Hearing Transcripts 2006

Public Hearing Transcripts 2 March 2006 – Socorro, New Mexico

1

ENVIRONMENTAL IMPACT STATEMENT
DEFENSE THREAT REDUCTION AGENCY

PUBLIC HEARING

MARCH 2, 2006
7:00 P.M.

MACY CENTER AUDITORIUM
SOCORRO, NEW MEXICO

KMR COURT REPORTERS, etc. LLC
Karen Rodriguez, CCR No. 55
(505) 243-2007

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2

JEFFERY THOMAS: Let's go ahead and get started. It's 7:00. I'm Jeff Thomas, and I'm the director of testing at the Defense Threat Reduction Agency. I want to personally welcome everybody to participate in the programmatic EIS improvement project.

I'm going to briefly cover some of the ground rules on how we do this little comment session, a little bit about the NEPA process, and I want to personally, on behalf of our director, let you know that the whole reason why we're doing this is we're at a stage where we need comments to make this thing happen.

I initiated this almost three years ago. And initiating a Programmatic Environmental Impact Statement process puts you under a guideline dictated by NEPA. So we're getting near the culmination of an effort that started three years ago, and we still need input to make this a better document. Again, the National Environmental Policy Act really establishes the guidelines for the Programmatic Environmental Impact Statement.

What we're doing here tonight is provide an objective review process to involve as many people as possible on the draft versions of these Programmatic Environmental Impact Statements.

The reason why we're doing this is that the Defense Threat Reduction Agency -- we are a new agency. We

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started in 1998. Our director and our agency is committed to follow all safety environmental guidelines that all federal organizations are supposed to be working under.

So what we want to do is to use this Programmatic EIS as a venue to take action to protect, restore and enhance environment in this particular case at White Sands Missile Range, where we currently have testing activities going on. We've been doing this since the agency started in 1998 under the Army Environmental Impact Statement Guidelines.

What we are doing as an agency is putting out our programmatic venues for why we do our testing in an open document so that you not only know what we're doing but the environmental risks associated with our test activities. Our role in the process is that we are the lead federal agency. We initiated this Programmatic Environmental Impact Statement. Second, we are working closely, obviously, with the Army at White Sands Missile Range.

So what we want to do tonight is to offer, with a court-trained reporter, the opportunity for everybody to provide oral comments. Secondly, throughout the Environmental Impact Statement review process mandated through NEPA, continuously through the review process, at anytime you can provide comments in writing. You can mail it to that address. You can fax it to that address, or you

Public Hearing Transcripts 2006

can e-mail it to that address. So we have all of these venues to get your comments in at this phase of the review process for this draft Programmatic Environmental Impact Statement.

At this meeting, we've made available copies here, and we've made copies available in public access places, for example, on a website, at libraries around the local area here. And at any time, we want you to take the time to review the document. And if you have any questions whatsoever on any part of that or any issues concerning that, provide those to us so we can make this a better document. That's why we're here. I just can't put it any more plain than that.

This is the public comments period. It's an hour and a half period of time. However, as I explained earlier, if you want to make a comment during this period and go on official record, obviously, we would like you to do that. If you don't, you can write your comments down and submit them in the back. If you want to make a public statement and submit it, you can do that as well.

The time line for the review period for this draft Programmatic EIS runs through March 28th, 2006. So at any time between now and then, if you have any comments that you want to provide, provide them to those venues, mail, fax, e-mail, and then we will make sure that that is

Public Hearing Transcripts 2006

entered into the process for coming out with the final draft of the Programmatic EIS, which will go out for one more review. And the proposed date for the record of decision made by our agency director is January '07. So those are the time lines that we have.

Again, there are two things that I want to stress during this public session, is we not only tell you what we're doing, but all of the environmental consequences associated with it and our assessment of the impact. We want to make this document the best to incorporate your concerns so that we can make a decision on which alternative to pursue.

At this time, what I would like to do is open it up for any public comments that people want to make. The ground rules for the public comments -- what I would like to say is to have those comments limited to a ten-minute period of time. We have a time keeper. Everything that is said as an oral comment will be recorded. And if you want to go back and review it during this period, please do. But again, at any time until March 28th, any comments that you want to provide you can provide through any of these methods. Are there any questions?

At this time, I would like to open it up if anybody wants to make a comment.

KATHRYN ALBRECHT: My name is Kathryn

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Albrecht. I'm from San Antonio, New Mexico. I work here at Tech in Socorro. I very much appreciate the fact that I am able to comment about the NEPA process, and I'm grateful that the north end of the missile range decided that they need to go with a PEIS.

I right away want to surface a question I have about the role in these particular test beds and facilities are utilized for the stated purpose, or maybe not. I know there have been areas out there that were prepared for certain tests, and those tests never occurred and then declared from this draft PEIS that those areas were then adapted and used for other testing initiatives such as those you were going to do in Socorro.

What happens when these facilities that are being covered in this PEIS, what happens when it's time for those areas to be either redeveloped for more projects, different projects? What sort of mechanism is in place to update the PEIS to cover -- is it amended? Is it revised? Do we go back to the drawing board? What is that mechanism? I would like to hear that addressed.

I congratulate the people that covered the environmental issues that were scoped, everything that they could think of to do for a responsible document. I think I will address any details that I am learning from studying the document in writing within the comment period.

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Tonight what I would like to address is the overall mission of the Defense Threat Reduction Agency, the overall mission of the pentagon and the government of the country in continuing to modernize our weapon capabilities, our war fighting capabilities and reflect on how it effects society.

When I look at what is going on, the incredible disablization of the national relations at this point in time and a war with no end in sight that has caused numerous civilian casualties and military casualties, I see one analysis that explains it all to me, because otherwise it sounds insane. And that is that there are private contractors, large corporations that make incredible profits with the contracts for the US military building weapons, weapons of mass destruction.

I mean if you dropped some of this on populated areas, there would be a lot of casualties, and you'd see the effects afterwards for many years to come. And we don't want that.

I don't know where you want to draw the line with weapons of destruction, but we make a lot of them. I believe that the stockholders of the weapons contractors in this country and the vast profits that they make is the engine driving this entire thing, and I believe that White Sands Missile Range plays a key role in allowing this to

Public Hearing Transcripts 2006

continue and to go on, this incredible expenditure and all of this toxification of the environment, not doing anything to reduce the threat to the planet, the threat to peace on earth or certainly the threat to our environmental struggles that we have.

You can describe the intents of the various test beds, the weapons that they intend to test, but we all know that probably in 18 months or so we're onto a whole new set of weapons. Our youth are not properly trained to handle these weapons the way maybe gunners on the battleship in the forties were able to, you know, work for several years with one set of ordinances and its delivery capabilities and get really really good at it. We just now change out the stuff so rapidly. The universities suck up the money to develop this stuff and test it out at White Sands, wherever else you're testing and put it out in the field. I would really like to see some true threat reduction.

JEFFERY THOMAS: Thank you.

KATHRYN ALBRECHT: You're welcome.

JEFFERY THOMAS: Are there any more comments that anybody else would like to make? We will be here tonight until 8:30 for the oral comment period. At any time, just let me know. Otherwise, I really appreciate you guys showing up tonight.

(Public comments concluded.)

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Karen Rodriguez, CCR No. 55
(505) 243-2007

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REPORTER'S CERTIFICATE

I, KAREN M. RODRIGUEZ, a certified court reporter, do hereby certify that I reported the foregoing case in stenographic shorthand and transcribed, or had the same transcribed under my supervision and direction, the foregoing matter and that the same is a true and correct record of the proceedings had at the time and place.

I FURTHER CERTIFY that I am neither employed by nor related to any of the parties or attorneys in this case, and that I have no interest whatsoever in the final disposition of this case in any court.

WITNESS MY HAND this 20th day of March, 2006.

Karen Rodriguez

Karen Rodriguez, CCR #55
Expiration 12/06

KMR COURT REPORTERS, etc. LLC
Karen Rodriguez, CCR No. 55
(505) 243-2007

APPENDIX C

PROTECTED FLORAL SPECIES ON WSMR

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COMMON NAME *(SCIENTIFIC NAME)*	HABITAT	ELEVATION (ft)	FEDERAL STATUS[a] (06/02)	STATE STATUS[a] (06/02)	KNOWN ON WSMR
APOCYNACEAE - Dogbane Family					
Fugate's amsonia Amsonia fugatei	Limy conglomerate ridges and associated outwash slopes in Chihuahuan desert scrub.	5,000-5,900	SC	SC	N
ASTERACEAE - Sunflower Family					
Sacramento mountains thistle Cirsium vinaceum	Wet soils at springs, seeps, and along streams in meadows or forest margins. The water is high in calcium carbonate that precipitates out to form large travertine mounds at some of the springs. May grow in almost pure stands on some of these mounds.	7,500-9,500	T	E	N
Wright's marsh thistle Cirsium wrightii	Wet, alkaline soils in springs, seeps and marshy edges of streams and ponds.	3,450-8,500	SC	SC	N
Guadalupe rabbitbush Ericameria nauseosa var. texensis	In crevices on faces of limestone cliffs and huge boulders of canyon woodlands, less frequently in open gravel alluvium of streambeds in piñon-juniper woodland and Chihuahuan desert scrub.	4,900-7,000	SC	SC	N
Sacramento Mountains fleabane Erigeron rybius	Meadows and forest openings in lower and upper montane coniferous forest.	7,000-9,000	SC	SC	N
Rock fleabane Erigeron scopulinus	Crevices in cliffs faces of rhyolitic rock in lower montane coniferous forest.	6,000-9,000	SC	SC	N
Tall bitterweed Hymenoxys brachyactis	Dry sites with coarse soils in piñon-juniper woodland and lower montane coniferous forest.	6,900-8,200	SC	SC	N
Vasey's bitterweed Hymenoxys vaseyi	Dry sites with coarse soils in montane scrub and piñon-juniper woodland.	6,900-8,200	SC	SC	Y
Sierra Blanca cliff daisy *Ionactis elegans*	Igneous rock faces in montane coniferous forest.	7,600-9,500	SC	SC	N
Gypsum scalebroom Lepidospartum burgessii	Stabilized gypsum dunes with Chihuahuan desert scrub and arid grasslands.	3,500-3,700	SC	E	N
Nodding cliff daisy Perityle cernua	Igneous cliffs, primarily on rhyolite, occasionally on andesite.	5,000-8,800	SC	SC	N
San Andres rock daisy *Perityle staurophylla* var. *homoflora*	Crevices in limestone cliffs, usually on protected north and east exposures.	6,400-7,000	SC	SC	Y

Source: New Mexico Rare Plant Technical Council. 1999. New Mexico Rare Plants. Albuquerque, NM: New Mexico Rare Plants Home Page. http://nmrareplants.unm.edu (Version 18 January 2006).
[a] E=Endangered; T=Threatened; SC=Species of Concern

ASTERACEAE - Sunflower Family (cont.)

New Mexico rock daisy *Perityle staurophylla* var. *staurophylla*	Crevices in limestone cliffs and boulders, usually on protected north and east exposures.	4,900-7,000	SC	SC	Y
Sacramento groundsel Senecio sacramentanus	Meadows and aspen glades in lower and upper montane coniferous forest.	8,000-11,000	SC	SC	N
BRASSICACEAE - Mustard Family					
Standley's whitlowgrass Draba standleyi	Igneous rock faces, bases of over hanging cliffs, clefts of porphyritic and andesitic rocks and soil.	5,500-6,500	SC	SC	N
Golden bladderpod Lesquerella aurea	Open sites and bare areas of rocky limestone soil, road banks, open woods in montane coniferous forest.	6,500-9,000	SC	SC	N
Goodding's bladderpod Lesquerella gooddingii	Open areas in piñon-juniper woodland and ponderosa pine forest.	6,000-7,500	SC	SC	N
Gray sibara Sibara grisea	In crevices at the base of limestone cliffs in interior chaparral and piñon-juniper woodland communities.	4,500-6,000	SC	SC	N
CACTACEAE - Cactus Family					
Kuenzlers's hedgehog cactus *Echinocereus fendleri* var. *kuenzleri*	Primarily on gentle, gravelly to rocky slopes and benches on limestone or limy sandstone, in Great plains grassland, oak woodland, or piñon-juniper woodland.	5,200-6,600	E	E	N
Duncan pincushion cactus Escobaria duncanii	Cracks in limestone and limy shale in broken terrain in Chihuahuan desert scrub.	5,100	SC	E	N
Organ Mountains pincushion cactus Escobaria organensis	On andesite, quartz-monzonite, and to a lesser extent rhyolite and limestone in broken mountainous terrain. Associated mostly with Chihuahuan desert scrub and open oak and piñon-juniper woodland.	None given	SC	E	Y
Sandberg pincushion cactus Escobaria sandbergii	Rocky, igneous and limestone soils in Chihuahuan desert scrub and open oak and piñon-juniper woodland in mountainous terrain.	4,200-7,400	SC	SC	Y
Sneed's pincushion cactus *Escobaria sneedii* var. *sneedii*	Primarily cracks in limestone in areas of broken terrain and steep slopes usually in Chihuahuan desert scrub.	None given	E	E	N
Villard pincushion cactus Escobaria villardii	Loamy soils of desert grassland with Chihuahuan desert habitats, including road sides in montane coniferous forest and piñon-juniper woodland.	4,500-6,500	SC	E	N
Dune prickly pear Opuntia arenaria	Sandy areas, particulary semi-stabilized sand dunes among open desert scrub, often with honey mesquite with sparse grass cover	3,800-4,300	SC	E	N
Night-blooming cereus *Peniocereus greggii* var. *greggii*	Habitat mostly in sandy to silty gravely soils in gently broken to level terrain in desert grassland or Chihuahuan desert scrub. Typically found growing up through and supported by shrubs, especially *Larrea tridentata* and *Prosopis glandulosa*.	None given	SC	E	Y

Source: New Mexico Rare Plant Technical Council. 1999. New Mexico Rare Plants. Albuquerque, NM: New Mexico Rare Plants Home Page. http://nmrareplants.unm.edu (Version 18 January 2006).
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CARYOPHYLLACEAE - Pink Family					
Plank's campion Silene plankii	Igneous cliffs and rocky outcrops.	5,000-8,000	SC	SC	Y
Wright's campion Silene wrightii	Cliffs and rocky outcrops in Rocky Mountain montane and subalpine conifer forest.	6,800-8,000	SC	SC	N
EPHEDRACEAE – Joint Fir Family					
Cory's joint-fir *Ephedra coryi*	On limestone, in dry sandy soils, and on dunes.	Below 5,000	SC	SC	Y
FABACEAE - Legume Family					
Tall milkvetch Astragalus altus	Limestone soils on steep slopes and road cuts in lower montane coniferous forest.	6,500-8,200	SC	SC	N
Castetter's milkvetch *Astragalus castetteri*	Dry, rocky slopes in montane scrub and open juniper woodland.	5,000-7,050	SC	SC	Y
Kerr's milkvetch Astragalus kerri	Dry, sandy or gravelly bars or benches of granitic alluvium in piñon-juniper woodland and lower ponderosa pine forest.	5,420-7,520	SC	SC	N
New Mexico milkvetch Astragalus neomexicanus	Dry hillsides and valley bottoms, in piñon-juniper woodland or ponderosa pine forest.	6,850-8,450	SC	SC	N
La Jolla prairie clover *Dalea scariosa*	Open sandy clay banks and bluffs, often along roadsides.	4,750-4,900	SC	SC	N
Sierra Blanca lupine Lupinus sierrae-blancae	Meadows and roadsides in pine and fir forest.	5,900-10,000	SC	SC	N
Guadalupe mescal bean *Sophora gypsophila* var. *guadalupensis*	Outcrops of pink, limy, fine-grained sand-stone that is 1-2 percent gypsum (by analysis) in Chihuahuan desert scrub and juniper savanna.	5,260-6,650	SC	SC	N
GROSSULARIACEAE – Angiosperm Family					
Mescalero black currant *Ribes mescalerium*	Dry slopes in open montane coniferous forests.	7,000-9,000	SC	SC	Y
LAMIACEAE - Mint Family					
Mosquito plant Agastache cana	Crevices and bases of granite cliffs or in canyons with small-leaved oaks at the upper edge of the desert and lower edge of the piñon zone.	4,600-5,900	SC	SC	Y
Organ Mountians giant hyssop *Agastache pringlei* var. *verticillata*	Humus-covered igneous talus and boulders at protected bases of steep cliffs in woodlands of Douglas fir, ponderosa pine and Gambel oak.	5,900-7,500	SC	SC	N
Mescalero pennyroyal *Hedeoma pulcherrimum*	Usually on steep hillsides, in rocky and/or disturbed habitats, including roadsides, in montane coniferous forest and piñon-juniper woodland.	5,000-9,000	SC	SC	Y

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LAMIACEAE - Mint Family (cont.)					
Todsen's pennyroyal Hedeoma todsenii	Plants grow in loose, gypseous-limestone soils associated with or positioned immediately below the Permian Yeso Formation, usually on steep north or east-facing slopes in piñon-juniper woodland.	6,200-7,400	E	E	Y
Supreme sage *Salvia summa*	Found almost exclusively on partly shaded limestone cliffs.	5,000-7,000	SC	SC	Y
LOASACEAE – Stick-leaf Family					
Guadalupe stickleaf *Mentzelia humilus* var. *guadalupensis*	Open gypsum outcrops of Yeso Formation, with limestone cobble	4,425-5,080	SC	SC	N
NYCTAGINACEAE – Four O'clock family					
Howard's gyp ringstem *Anulocaulis leiosolenus* var. *howardii*	Open gypsum outcrop of Yeso Formation, with limestone cobble	4,425-4,750	SC	SC	N
ONAGRACEAE – Evening Primrose Family					
Organ Mountain evening primrose Oenothera organensis	Seeps, springs, and colluvium substrates in the bottom of drainages in montane scrub and piñon-juniper-oak woodland.	5,700-7,600	SC	SC	Y
ORCHIDACEAE – Orchid Family					
Arizona coralroot *Hexalectris spicata* var. *arizonica*	In heavy leaf litter in oak, pine, or juniper woodlands over limestone.	Not given	SC	SC	N
PAPAVERACEAE – Poppy Family					
Sacramento prickly poppy *Argemone pleiacantha* var. *pinnatisecta*	Loose, gravelly soils of open disturbed sites; canyon bottoms and slopes, and sometimes along roadsides.	4,200-7,100	E	E	N
POACEAE – Grass Family					
Mohave panicum *Panicum mohavense*	Limestone terraces and cliffs in Great Plains desert scrub in Arizona and piñon-juniper woodland in New Mexico.	1,300-2,400	SC	SC	Y
POLYGONACEAE – Buckwheat Family					
Wooten's wild buckwheat *Erigonum jamesii* var. *wootonii*	Mountain slopes and small openings in lower and upper montane coniferous forests.	6,000-11,500	SC	SC	Y
POLYGALACEAE - Milkwort Family					
Mescalero milkwort *Polygala rimulicola* var. *mescalerorum*	Crevices in sandy limestone cliffs in montane scrub.	5,700-6,300	SC	E	Y

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RANUNCULACEAE – Buttercup Family					
New Mexico larkspur Delphinium novomexicanum	Canyon bottoms, forest meadows and road banks in lower and upper montane coniferous forest.	7,200-11,200		SC	N
ROSACEAE – Rose Family					
Wooton's hawthorn Crataegus wootoniana	Canyon bottoms and forest understory in lower montane coniferous forest.	6,500-8,000		SC	N
SAXIFRAGACEAE – Saxifrage Family					
Wooton's alumroot Heuchera wootonii	Mountain slopes and protected, usually north-facing rock outcrops, or Gamble oak thickets in piñon-juniper woodland and lower montane coniferous forest.	7,000-12,000		SC	N
SCROPHULARIACEAE - Figwort Family					
Organ Mountains paintbrush Castilleja organorum	Flat, seasonally wet areas in arid grasslands.	5,200-6,900		SC	N
Alamo beardtongue *Penstemon alamosensis*	Sheltered rocky areas, canyon sides and bottoms on limestone.	4,300-5,300	SC	SC	Y
Scarlet penstemon *Penstemon cardinalis* spp. *cardinalis*	Canyon bottoms and rocky slopes in piñon-juniper woodland and lower montane coniferous forest.	7,000-9,000		SC	N
Guadalupe penstemon *Penstemon cardinalis* ssp. *regalis*	Limestone slopes and canyon bottoms in montane scrub, piñon-juniper woodland, and lower montane coniferous forest.	4,500-6,000		SC	N
Metcalfe's penstemon Penstemon metcalfei	Cliffs or steep, north-facing slopes in lower and upper montane coniferous forest.	6,600-9,500		SC	N
New Mexico beardtongue *Penstemon neomexicanus*	Wooded slopes or open glades in ponderosa pine or spruce/fir forests.	6,000-9,000		SC	Y
San Mateo penstemon Penstemon pseudoparvus	Open ponderosa pine or spruce-fir forest and high montane meadows.	9,000-10,000		SC	N
Smooth figwort Scrophularia laevis	Moist canyons on quartz monzonite substrate in piñon-juniper woodland and Rocky Mountain montane coniferous forest.	6,900-8,500	SC	SC	N

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APPENDIX D

PROTECTED FAUNAL SPECIES ON WSMR

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TES Faunal Species that Occur or Potentially Occur on WSMR

Taxonomic Class	Scientific Name	Common Name	Federal Status	State Status
Aves	*Haliaeetus leucocephalus*	bald eagle	**T**	**T**
Aves	*Falco femoralis septentrionalis*	northern aplomado falcon	**E**	**E**
Aves	*Falco peregrinus anatum*	American peregrine falcon	**SOC**	**T**
Aves	*Columbina passerina*	common ground dove		**E**
Aves	*Cyanthus latirostris*	broad-billed hummingbird		**T**
Aves	*Calypte costae*	Costa's hummingbird		**T**
Aves	*Empidonax traillii extimus*	southwestern willow flycatcher	**E**	**E**
Aves	*Vireo bellii*	Bell's vireo	**SOC**	**T**
Aves	*Vireo vicinior*	gray vireo		**T**
Aves	*Passerina versicolor*	varied bunting		**T**
Aves	*Sterna antillarum athalassos*	interior least tern	**E**	**E**
Aves	*Ammodramus bairdii*	Baird's sparrow	**SOC**	**T**
Aves	*Charadrius melodus*	piping plover	**T**	**E**
Aves	*Coccyzus americanus*	yellow-billed cuckoo	**C**	
Aves	*Strix occidentalis lucida*	Mexican spotted owl	**T**	
Mammalia	*Tamias quadravittatus australis*	Organ mountain Colorado chipmunk	**SOC**	**T**
Mammalia	*Tamias quadravittatus oscuraensis*	Oscura Colorado chipmunk		**T**
Mammalia	*Ovis Canadensis mexicana*	desert bighorn sheep		**E**
Mammalia	*Zapus hudsonius luteus*	New Mexican jumping mouse	**SOC**	**T**
Mammalia	*Euderma maculatum*	spotted bat		**T**
Mammalia	*Cynomys ludovicianus*	black-tailed prairie dog	**SOC**	
Osteichthyes	*Cyprinodon tularosa*	White Sands pupfish	**SOC**	**T**
Reptilia	*Crotalus lepidus lepidus*	mottled rock rattlesnake		**T**

E=Endangered; T=Threatened; C= Candidate; SOC=Species of Concern.
(NMNHP, 2003; USFWS, 2003; NMDGF 2006)

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APPENDIX E

HAZARD RATINGS FOR DTRA TEST MATERIALS

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Test Material	[5]NFPA			[5]Listed as Hazardous by:			
EIS Entry	Health	Flammablity	Reactivity	DOT	EPA	Other	Discussion of Material
Biological Simulants (Amount per test)							
Bacillus subtilis var. niger (formerly *Bacillus globigii*) (BG) (200 lbs)	0	0	0	No	No	Biosafety Level 1 (CDC, ATCC)	F-5
Bacillus thuringiensis bacteriophage (5 lbs/test)	0	0	0	No	No	Biosafety Level 1 (ATCC)	F-8
Bacillus thuringiensis (BT) (68038-71-1) (200 lbs)	0	0	0	No	No	Biosafety Level 1 (CDC, ATCC)	F-8
Clostridium sporogenes (150 lbs)	0	0	0	No	No	Biosafety Level 1 (CDC, ATCC)	F-10
Erwinia herbicola (Ec) (200 lbs/test)	0	0	0	No	No	Biosafety Level 1 (CDC, ATCC)	F-11
Lactic Dehydrogenase (LDH) (200 lbs)	0	0	0	No	No	Biosafety Level 1 (CDC, ATCC)	F-12
MS2 Bacteriophage (150 lbs)	0	0	0	No	No	Biosafety Level 1 (CDC, ATCC)	F-12
Noninfectious (killed) Influenza A Virus (150 lbs)	0	0	0	No	No	Biosafety Level 1 (CDC, ATCC)	F-13
Ovalbumin (CAS 9006-59-1) (200 lbs)	0	0	0	No	No	Biosafety Level 1 (CDC, ATCC)	F-14
Chemical Simulants (Amount per test)							
1, 3, 5 Trimethylbenzene (mesitylene) (CAS 108-67-8)(4000 gal)	2	2	0	Class 3	No	Yes (OSHA)	F-15
Bis (2-ethylhexyl) hydrogenphosphite (Bis) (CAS 3658-48-8)(4000 gal)	1 (est)	1 (est)	3 (est)	No	No	No	F-16
Diethyl malonate (CAS 105-53-3)(4000 gal)	0	1	0	Class 6 Division 1	Yes (TSCA)	No	F-18
Diethyl phthalate (CAS 84-66-2)(4000 gal)	0	1	0	No	No	Yes (OSHA)	F-18
Dimethyl Methylphosphonate (DMMP) (CAS 756-79-6) (4000 gal)	3	2	1	No	Yes	No	F-20
Dipropylene glycol monomethyl ether (DPM; DPGME) (CAS 34590-94-8) (4000 gal)	1	2	0	No	Yes	Yes (OSHA)	F-22
Glyceryl tributyrate (CAS 60-01-5)(4000 gal)	0	1	0	No	No	No	F-23
Methyl salicylate (MeS) (CAS 119-36-8) (4000 gal)	1	1	0	No	No	No	F-24
Propionic acid (CAS 79-09-4)(4000 gal)	3	2	0	Class 8	No	No	F-26
Thiodiglycol (TDG) (CAS 111-48-8) (4000 gal)	2	1	0	No	No	No	F-27
Tributyl phosphate (CAS 126-73-8) (4000 gal)	2	1	1	No	No	Yes (OSHA)	F-28
Triethyl phosphate (TEP; TEPO) (CAS 78-40-0) (4000 gal)	0	1	1	No	No	No	F-29
Triethyl phosphite (TEPI) (CAS 122-52-1) (4000 gal)	3	2	2	Class 3	No	No	F-31
Triisopropyl phosphate (CAS 513-02-0)(4000 gal)	2	3	0	No	No	No	F-31
Trimethyl phosphite (CAS 121-45-9)(4000 gal)	1	3	0	No	No	No	F-32
Tripropyl phosphate (CAS 513-08-6)(4000 gal)	2	1	1	No	No	No	F-33
Radiogical Simulants (Amount per test)							
Cerium dioxide (CeO_2) (CAS 1306-38-3) (5 kg)	1	0	0	No	No	No	F-35
Cesium chloride (CsCl) (CAS 7647-17-8) (5 kg)	0	0	0	No	No	Yes (OSHA)	F-35
Manganese dioxide (MnO_2) (CAS 1313-13-9) (5 kg)	2	0	1	No	No	Yes (OSHA)	F-36

Strontium titanate ($SrTiC_3$) (CAS 12060-59-2) (5 kg)	1	0	0	No	No	Yes (OSHA)	F-37
Tracers and Taggants (Amount per test)							
BAS-Oil Red Dye (20 gal)	1	0	0	No	No	No	F-39
Carbon Tetrafluoride (CF_4) (CAS 75-73-0) (150 lbs)	1	0	0	Class 6 Division 1	Yes	Yes (OSHA)	F-39
2-Diethylamino ethanethiol (CAS 1942-52-5) (400 gal/test)	2	0	0	No	No	No	F-40
2-Diisopropylamino ethanethiol (CAS 41480-75-5) (400 gal/test)	2	0	0	No	No	No	F-41
Dysprosium Oxide (CAS 1308-87-8) (100 lbs)	0	0	0	No	No	Yes (OSHA)	F-42
Fluorescein (CAS 2321-07-5) (110 lbs/test)	1	1	0	No	No	No	F-43
Forane 134A (1,1,1,2-tetrafluoroethane) (CAS 811-97-2) (100 lbs)	1	0	0	Class 2 Division 2	Yes	Yes (OSHA)	F-43
Indium Oxide (CAS 1312-43-2) (100 lbs)	1	0	0	No	No	No	F-44
Locate Blue Liquid Dye (40 gal)	1	0	0	No	No	No	F-46
Malachite green (CAS 633-03-4) (110 lbs/test)	2	0	0	No	No	No	F-48
Pentafluoroethane (PFE; Halocarbon 125; Zyron 125) (CAS 354-33-6) (250 lbs/test)	1	0	0	Class 2 Division 2	No	No	F-49
Scandium Oxide (CAS 12060-08-1) (100 lbs)	3	0	2	Class 8	Yes	Yes (OSHA)	F-50
Sulfur Hexafluoride (SF_6) (CAS 2551-62-4) (250 lbs)	2	0	0	Class 2 Division 2	Yes	Yes (OSHA)	F-51
Interferents (Amount per test)							
Bleach (55 Gal)	3	0	1	Class 8	Yes	Yes (OSHA)	F-55
Burning butyl rubber (burning organics) (increase from 4 to 12 large tires)	1	3	0	No	No	Yes (OSHA)	F-56
Burning Kerosene or diesel fuel (combustion products) (100 gal)	1	2	0	Class 3	Yes	Yes (OSHA)	F-57
Burning Plastic (burning organics) (15 lbs)	3	3	2	No	No	Yes (OSHA)	F-56
Burning Wood (burning organics) (100 lbs)	1	1	0	No	No	Yes (OSHA)	F-56
Other Test Material (Amount per test)							
Bentonite Clay (CAS 1302-78-9) (100 lbs/test)	1	0	0	No	Yes	Yes (OSHA)	F-59
Kaolin (600 lbs) (CAS 1332-58-7)	1	0	0	No	No	Yes (OSHA)	F-60
Luria Broth (LB) (55 lbs/test)	0	0	0	No	No	Yes (OSHA)	F-61
Magnesium chloride (250,000 lbs) (CAS 7786-30-3)	2	0	0	No	No	No	F-61
Oleoresin capsicum (10 lbs) (CAS 404-86-4)	2	1	1	No	No	No	F-62
Phenol (22 lbs) (CAS 108-95-2)	4	2	2	Class 6 Division 1	Yes	Yes (OSHA)	F-63
Polymethyl Methacrylate (PMMA) (2300 lbs) (CAS 9011-14-7)	1	1	0	No	No	Yes (OSHA)	F-65
Polystyrene (CAS 9003-53-6) (25 lbs/test)	1	0	0	No	No	No	F-67
Polystyrene-Butylmethacrylate (PSBA) (2300 lbs)	2	2	1	No	Yes	No	F-67
Sand (silica) (CAS 14808-60-7) (25 lbs/test)	2	0	0	No	No	Yes (OSHA)	F-68
Silicon (CAS 7440-21-3) (5 lbs/test)	1	3	0	Class 4 Division 1	No	Yes (OSHA)	F-69

Smokecloak FL 600 Fluid (3 gal)	2 (est)	3 (est)	1 (est)	No	No	No	F-70
Sticky Foam (1200 lbs)	1	1	0	No	No	Yes (OSHA)	F-71
Tergitol 15-S-9 Nonionic (20 lbs) (CAS 68131-40-8)	2	1	1	No	Yes	Yes (OSHA)	F-73

High Explosives
(Amount per test)

AFX-757 (20,000 lbs)	1 (Al)/1 (est-expl)	1 (Al)/4 (est-expl)	1 (Al)/4 (est-expl)	Class 1 Division 1	No (Al)/Yes	Yes (ATF/OSHA)	F-75
AFX-777 (2500 lbs)	1 (Al)/1 (est-expl)	1 (Al)/4 (est-expl)	1 (Al)/4 (est-expl)	Class 1 Division 1	No (Al)/Yes	Yes (ATF/OSHA)	F-75
Ammonium nitrate-fuel oil (ANFO) (500 Ton TNT equivalent)	1	2	4	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-75
APHAS-4 (2500 lbs)	NK	NK	NK	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-77
Composition 4 (C-4) (91% RDX; 9% plasticizer) (2 tons) (CAS 121-82-4)	1	3	4	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-77
Cyclotetramethylenetetranitramine (HMX) (1 ton) (CAS 2691-41-0)	1	4	4	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-79
Cyclotrimethylenetrinitramine (RDX) (1 ton) (CAS 121-82-4)	1	3	4	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-77
Emulsion Explosives Iregel-82, Iremite-62, QM-100, QM-100R (23 tons)	1	3	4	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-80
GSI-0005 (2500 lbs)	1 (BA)/3 (PA)	0 (BA)/0 (PA)	0 (BA)/0 (PA)	Class 8	No (BA/PA)	Yes (OSHA)	F-81-82
GSI-0018 (2500 lbs)	1 (BA)/3 (PA)	0 (BA)/0 (PA)	0 (BA)/0 (PA)	Class 8	No (BA/PA)	Yes (OSHA)	F-81-82
HAS-4 (2500 lbs)	NK	NK	NK	Class 1 Division 1	No	Yes (OSHA)	F-83
HAS-12 (2500 lbs)	1	4	4	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-84
MAC-112 (2500 lbs)	NK	NK	NK	Class 1 Division 1	No	No	F-84
Nitromethane (NM) (20 tons) (CAS 75-52-5)	1	3	4	Class 3	Yes	Yes (ATF/OSHA)	F-82
PBXC-133 (2500 lbs)	1	4	4	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-85
PBXIH-135 (2500 lbs)	1	3	4	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-85
PBXIH-136 (2500 lbs)	1	3	4	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-85
PBXN-103 (2500 lbs)	1	3	4	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-85
PBXN-109 (2500 lbs)	1	3	4	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-85
PBXN-111 (2500 lbs)	1	3	4	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-85
PBXW-128 (2500 lbs)	1	4	4	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-85
Pentaerythritol tetranitrate (PETN) (1000 lbs) (CAS 78-11-5)	1	4	4	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-86
Pentolite (1000 lbs) (CAS 8066-33-9)	1 (est)	2 (est)	4 (est)	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-87
Red Phosphorus (CAS 7723-14-0)(2500 lbs)	0	2	2	Class 4 Division 1	Yes	Yes (OSHA)	F-87
Trinitrotoluene (TNT) (500 lbs) (CAS 118-96-7)	2	4	4	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-89
Tritonal (increase limit from 1000 lbs to 20,000 lbs)	1 (est)	2 (est)	4 (est)	Class 1 Division 1	Yes	Yes (ATF/OSHA)	F-90
White Phosphorus (CAS 7723-14-0) (2500 lbs)	0	2	2	Class 4 Division 1	Yes	Yes (OSHA)	F-87

Energetic/Reactive Materials

Aluminum (CAS 7429-90-5)	1	3	1	Class 4 Division 3	No	Yes (OSHA)	F-95

Ammonium Nitrate (CAS 6484-52-2)	2	0	3	Class 5 Division 1	No	No	F-97
Ammonium Perchlorate (CAS 7790-98-9)	1	0	4	Class 5 Division 1	Yes	No	F-98
Boron (CAS 7440-42-8)	1	0	0	No	No	No	F-98
Hexachloroethane (CAS 67-72-1)	4 (est)	1(est)	1(est)	No	Yes	Yes (OSHA)	F-100
Isopropyl nitrate (IPN) (CAS 1712-64-7)	2	3	1	Class 3	No	No	F-101
Magnesium (CAS 7439-95-4)	0	1	1	Class 4 Division 1	No	Yes (OSHA)	F-102
Potassium Perchlorate (CAS 7778-74-7)	2	0	2	Class 5 Division 1	No	Yes (OSHA)	F-103
Sodium Perchlorate (CAS 7601-89-0)	2	0	2	Class 5 Division 1	No	Yes (OSHA)	F-103
Teflon Polymer (Viton, Teflon) (PTFE)(CAS 9002-84-0)	2	0	0	No	No	No	F-104
Titanium (CAS 7440-32-6)	1	3	2	No	No	Yes (OSHA)	F-104
Rocket Propellants							
Ammonium Perchlorate/Aluminum/ binder propellants (AP/Al)	1 (AP/Al)	0 (AP) 3 (Al)	4 (AP) 1(Al)	Class 5 Division 1 (AP) Class 4	Yes (AP) No (Al)	Yes (Al-OSHA) / No (AP)	F-107
Inhibited Red Fuming Nitric Acid (IRFNA) (CAS 7697-37-2)	4	0	1	Not Regulated	Yes	Yes (OSHA)	F-107
Nitrate Ester propellants (Nitroglycerin - NG & Nitrocellulose - NC)	0 (NC)/3 (NG)	3 (NC)/4 (NG)	3 (NC)/3 (NG)	Class 4 Division 1 (NC)/Class 3 (NG)	Yes	Yes (ATF)[1]	F-109-110
Triamino-trinitrobenzene TATB (CAS 3058-38-6)	1 (est)	1 (est)	4 (est)	Class 1 Division 1	Yes	Yes (ATF)[1]	F-110
Unsymmetrical Dimethyl Hydrazine (UDMH) (CAS 57-14-7)	4	3	1	Class 6 Division 1	Yes	Yes (OSHA)	F-111
Non-Energetic Test Materials							
Alumina (aluminum oxide) (CAS 1344-28-1) (600 lbs)	1	1	1	Not Regulated	Yes	Yes (OSHA)	F-114
Benzyl mercaptan (CAS 100-53-8)	2	2	1	Class 6 Division 1	No	No	F-115
Boron trifluoride (BF_3) (CAS 7637-07-2)	4	0	1	Class 2 Division 3	Yes	Yes (OSHA)	F-116
Bromine (CAS 7726-95-6)	4	0	3	Class 8, Class 6.1	Yes	Yes (OSHA)	F-118
Bromine Trifluoride (BrF_3) (CAS 7787-71-5)	3	0	3	Class 5 Division 1	No	Yes (OSHA)	F-119
Butyl mercaptan (CAS 109-79-5)	2	3	0	Class 3	No	Yes (OSHA)	F-120
Butyric Acid (CAS 107-92-6)	3	2	0	Class 8	No	Yes (OSHA)	F-122
Calcium Oxide (CAS 1305-78-8)	2	0	0	Class 8	No	Yes (OSHA)	F-123
Carbon fibers and nanotubes, various sizes	0	1	0	No	No	Yes (OSHA)	F-123
Cetyltrimethyl ammonium bromide (CAS 57-09-0)	2	0	0	Class 9	No	No	F-124
Cetyltrimethylammonium chloride (CAS 112-02-7)	2	0	0	Class 9	No	No	F-125
Chlorine (7782-50-5)	4	0	0	Class 2 Division 3	No	Yes (OSHA)	F-126
Chlorine Pentafluoride (ClF_5) (CAS 13637-63-3)	4 (est)	2 (est)	2 (est)	Class 2 Division 3	No	Yes (OSHA)	F-126
Chlorine Trifluoride (ClF_3) (CAS 7790-91-2)	4	0	3	Class 2 Division 3	No	Yes (OSHA)	F-127
Cyclohexyl mercaptan (CAS 1569-69-3)	2	2	0	Class 3	No	No	F-128
Ethyl 2-cyanoacrylate (CAS 7085-85-0)	2	2	1	Class 3	No	Yes (OSHA)	F-128
Ethyl mercaptan (CAS 75-08-1)	2	4	0	Class 3	Yes	Yes (OSHA)	F-129
Fog Oil (Naphthenic Oil) (CAS 64742-52-5)	2	2	0	No	No	Yes (OSHA)	F-130
Glycerol (CAS 56-81-5)	1	1	0	No	No	Yes (OSHA)	F-131

Hexachlorobenzene (CAS 118-74-1)	4 (est)	4 (est)	3 (est)	Class 6 Division 1	Yes	Yes (OSHA)	F-132
Isopropyl mercaptan (CAS 75-33-2)	1	3	0	Class 3	No	No	F-134
Magnesium Oxide, MgO (CAS 1309-48-4)/(2.20 lbs per test)	1	0	1	No	No	Yes (OSHA)	F-135
Mercaptoacetic acid (CAS 68-11-1)	3	1	0	Class 8	No	No	F-136
2-Mercaptoethanol (CAS 60-24-2)	2	2	0	Class 6	No	No	F-137
3-Mercaptopropionic acid (CAS 107-96-0)	4 (est)	1 (est)	2 (est)	Class 8	No	No	F-138
3-Methyl indole (CAS 83-34-1)	1	1	0	No	No	No	F-139
Methyl mercaptan (CAS 74-93-1)	3	4	0	Class 2 Division 3	Yes	Yes (OSHA)	F-140
1-Methyl-1-propanethiol (CAS 513-53-1)	2	3	0	Class 3	No	Yes	F-141
2-Methyl-2-propanethiol (CAS 75-66-1)	0	3	0	Class 3	No	No	F-142
Methyltrioctadecylammonium bromide (CAS 18262-86-7)	1 (est)	1 (est)	1 (est)	No	No	No	F-143
Methyltrioctylammonium bromide (CAS 35675-80-0)	1 (est)	0 (est)	0 (est)	No	No	No	F-143
Methyltrioctylammonium chloride (CAS 63393-96-4)	2	0	1	Class 6 Division 1	No	No	F-144
1-Octanethiol (CAS 111-88-6)	2	2	0	No	No	No	F-144
2,2'-Oxydiethanethiol (2-mercaptoethyl ether) (CAS 2150-02-9)	2 (est)	2 (est)	2 (est)	No	No	No	F-145
Polyethylene glycol (CAS 25322-68-3)	0	1	0	No	No	Yes (OSHA)	F-145
Terephthalic Acid (CAS 100-21-0)	0	1	0	No	No	Yes (OSHA)	F-146
Tetraoctylammonium bromide (CAS 14866-33-2)	1 (est)	1 (est)	1 (est)	No	No	No	F-147
Tetraoctylammonium chloride (CAS 3125-07-3)	2 (est)	1 (est)	1 (est)	No	No	No	F-148
Thiophenol (CAS 108-98-5)	3	2	0	Class 6 Division 1	Yes	Yes (OSHA)	F-148
Trimethylamine (TMA) (CAS 75-50-3)	3	4	0	Class 3	Yes	Yes (OSHA)	F-149
Tungsten (VI) Fluoride (WF6) (CAS 7783-82-6)	3	0	2	Class 2 Division 3	No	Yes (OSHA)	F-151

Alternative Two

Chemical Simulants

Bis(2-ethylhexyl) phosphate (DEPHA) (CAS 298-07-7)(4000 gal)	3	1	0	Class 8	No	No	F-152
2-Chloroethyl ethyl sulfide (CEES) (CAS 693-07-2)(4000 gal)	2	2	0	Yes	No	No	F-153
Diethyl methyl phosphonate (DEMP) (CAS 683-08-9)(4000 gal)	4	1	1	Class 6 Division 1	Yes	Yes (CWC)	F-154
Diisopropyl fluoro phosphate (DFP) (CAS 55-91-4)(4000 gal)	4	0	0	No	No	No	F-154
Diisopropyl methyl phosphonate (DIMP) (CAS 1445-75-6) (4000 gal)	4	1	1	Class 6 Division 1	Yes	Yes (OSHA)	F-155

Tracer and Taggants

Lead (II) Selenide (CAS 12069-00-0)	2	0	1	Class 6 Division 1	Yes	Yes (OSHA)	F-156
Lead (II) Telluride (CAS 1314-91-6)	3	0	0	No	No	Yes (OSHA)	F-157
Mercuric Sulfide Red (CAS 1344-48-5)	2	0	0	Class 6 Division 1	No	Yes (OSHA)	F-158
Mercury (II) Selenide (CAS 20601-83-6)	3	0	1	Class 6 Division 1	No	Yes (OSHA)	F-159
Mercury (II) Telluride (CAS 12068-90-5)	3	0	1	Class 6 Division 1	No	Yes (OSHA)	F-160

KEY

Estimated: est

Footnote:

[5]NFPA and Hazardous ratings were cited from Material Safety Data Sheets.

NFPA Ratings

Health

0 – Not a health hazard

1 – Irritation if touched or breathed but no destruction of tissue; minor injury if no medical treatment

2 – High irritation if touched or breathed ; temporary incapacitation or residual injury if no medical treatment

3 – Corrosive or toxic if touched or breathed; serious injury if no medical treatment

4 – Extreme hazard if touched or breathed, and can penetrate protective clothing; death if no medical treatment

Flammability

0 – Not a fire hazard

1 – Liquids, solids, and semisolids with flash point above 200°F

2 – Liquids with flash point between 100°F and 200°F; solids and semisolids which give off flammable vapors

3 – Liquids with flash point between 73°F and 100°F; materials which burn rapidly or ignite spontaneously with air

4 – Liquids with flash point below 73°F; materials which form explosive mixtures with air; cryogenic materials

Reactivity

0 – Stable even under fire conditions; does not react with water

1 – Unstable at high temperatures and pressures; non-violent reaction with water

2 – Unstable at normal temperatures and pressures, but does not detonate; violent reaction with water

3 – Detonation possible at normal temperatures and pressures if strong thermal or mechanical shock; explosive reaction with water

4 – Detonation possible at normal temperatures and pressures if localized mechanical or thermal shock

Department of Transportation

Class 1 EXPLOSIVES

Division 1	Mass explosion hazard, where a mass explosion is an explosion which affects entire load instantaneously
Division 5	Insensitive mass explosion hazard, where mass explosion could occur but is highly unlikely to occur under normal transport conditions.

Class 2 GASES

Division 2	Flammable gas hazard, where a flammable gas is defined as any material which is a gas at 68°F or less and 14.7 psi of pressure, and is ignitable at 14.7 psi when in a mixture of 13% or less with air.

Class 3 FLAMMABLE LIQUID HAZARD

A flammable liquid is defined as any liquid with a flash point of 141°F or less.

Class 4 FLAMMABLE SOLIDS; SPONTANEOUSLY COMBUSTIBLE MATERIALS; AND DANGEROUS WHEN WET MATERIALS

Division 1	Flammable solids
Division 2	Spontaneously combustible materials
Division 3	Dangerous when wet materials

CLASS 5 OXIDIZERS AND ORGANIC PEROXIDES

Division 1	Oxidiziers
Division 2	Organic Oxidiziers

Class 6 POISONOUS MATERIALS

Division 1	Human irritation or toxicity hazard, where irritating material is defined as any material which causes symptoms similar to tear gas; and toxic material is defined as any material with a 50% lethal oral dose of at most 500 mg/kg (liquid) or 200 mg/kg (solid), a 50% lethal topical dose of at most 1000 mg/kg, or a 50% lethal inhalation concentration of at most 10 mg/L.

Class 8 CORROSIVE MATERIAL HAZARD

A corrosive material is defined as any material which causes destruction of human skin upon contact for a specified period of time.

Other Definitions

CDC	Biohazard 1 is defined as any biological agent that is not known to cause disease in healthy human adults and poses minimal potential hazard to the environment
EPA	Chemical substances listed as hazardous under EPA are monitored by at least one of the following EPA programs: Aerometric Information Retrieval System Facility Subsystem (AFS) for chemical releases into air; Permit Compliance System (PCS) for chemical releases into water; Toxic Release Inventory System (TRIS) for release of toxic substances into environment; and Resource Conservation and Recovery Information System (RCRIS) for hazardous waste.
OSHA	Chemical substances considered hazardous by OSHA are those substances which have an established Permissible Exposure Limit (PEL) as specified by OSHA, an established Threshold Limit Value (TLV) as specified by the American Conference of Governmental Industrial Hygienists (ACGIH), an established threshold limit as specified by the manufacturer, or are known to be a carcinogen as specified by the National Toxicology Program (NTP) or the International Agency for Research on Cancer (IARC).

APPENDIX F

CHARACTIERISTICS AND PROPERTIES OF DTRA TEST MATERIALS

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TABLE OF CONTENTS

LIST OF FIGURES

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1.0 INTRODUCTION

Threat of weapons of mass destruction (WMD), such as pathogenic biological agents and highly toxic chemical agents, is cause for concern for the United States and its allies. As a result, the United States military conducts research on the human and environmental toxicity of these agents and methods of destruction of these agents. Because of the obvious hazards inherent in handling and releasing WMD, less pathogenic and less toxic agents are used in some tests as simulants of the actual agents.

Chemical and biological simulants have been used by the United States military for the last 57 years for testing and training. Research and development is conducted at the United States Army Soldier Biological Chemical Command (SBCCOM) at Edgewood Arsenal of Aberdeen Proving Grounds, MD and the Dugway Proving Grounds, Utah. For example, the Biological Integrated Detection System [BIDS] was developed at SBCCOM as a method of detecting biological warfare agents on the battlefield. Tests employing simulants have occurred at Dugway Proving Grounds, UT, White Sands Missile Range (WSMR), NM, and the Nevada Test Site in order to test the sensitivity of equipment to detect WMD and model plume behavior. From plume data, predictions can be made about the movement of biological and chemical agents through the air after defeat of enemy production and storage facilities.

Simulants have also been used for training of troops at the United States Army Chemical School since 1990 (first located at Fort McClellan, AL and later moved to Fort Leonard Wood, MO) and Fort Polk, LA since 2000. At Fort Polk, troops are trained in the use of BIDS. At the United States Army Chemical School, troops are trained in the detection of WMD and decontamination techniques.

Continued testing employing simulants is proposed at WSMR at the Defense Threat Reduction Agency (DTRA) test beds in order to test the sensitivity of equipment to detect WMD and to model plume behavior under different scenarios. Simulants are chosen which mimic particular physical and/or chemical properties of the actual WMD agents. Biological simulants are bacteria and viruses that are closely related to biological warfare agents. Most of the chemical simulants are precursors (production intermediates) and/or degradation products of the actual chemical warfare agents. Although simulants are not nearly as injurious as actual WMD, some are considered hazardous under EPA and OSHA regulations. The following sections contain a detailed literature review on the environmental fate and specific environmental and human hazards of each of the proposed simulants and related test materials.

Definitions of toxicity used in this document come from Munro et al. (1999). Toxicity may be acute (toxic after one-time exposure) or chronic (toxic after multiple or long-term exposures). The three routes of animal exposure to simulants are oral, inhalation, and dermal. Oral and dermal toxicities are determined by 50% lethal dose (LD_{50}), the dose at which half of the test organisms died. Inhalation toxicity is determined by 50% lethal concentration (LC_{50}), the atmospheric concentration at which half the test organisms died. Compounds that are considered to be of low acute toxicity are those that have an LD_{50} or LC_{50} greater than 500 mg/kg of body weight for oral and dermal exposure, and greater than 500 mg/m^3 of atmosphere for inhalation exposure. Compounds that are of moderate acute toxicity are those that have an LD_{50} or LC_{50} between 50-500 mg/kg (oral), between 200-500 mg/kg (dermal), and between 50-500 mg/m^3 (inhalation). Compounds that are of high acute toxicity are those that have LD_{50} or LC_{50} less than 50 mg/kg (oral), less than 200 mg/kg (dermal) and less than 50 mg/m^3 (inhalation). High acute toxicity for aquatic organisms is LC_{50} less than 1 mg/L.

Generally, the biological and chemical simulants proposed for use at DTRA test beds are not highly toxic. Some simulant compounds have a long lifetime in the environment (also called "persistence"). Persistent compounds have the potential to build-up in the soil or groundwater, and may bio-accumulate in plants and animals. This document uses definitions of environmental persistence as outlined by Munro et al. (1999): moderate persistence refers to compounds that are stable for weeks to months (half-life between 2 and 16 weeks) and high persistence refers to compounds that are stable for months to years (half-life greater than 16 weeks).

Plume modeling programs were employed to predict the extent of chemical releases in the environment by variety of release methods. Two such models were used, Areal Locations of Hazardous Atmospheres (ALOHA) and Hazard Prediction and Assessment Capability (HPAC), which can predict the extent of concentration by the users input such as wind speed and temperature to name a few. The models showed the extent of the chemical releases and their predicted concentrations.

The HPAC modeling software was developed to predict the effects of hazardous nuclear, biological, and/or chemical material releases into the atmosphere and their impact on civilian or military populations resulting from conventional weapon strikes against potential target facilities by an enemy (DTRA, 2004). HPAC concentrations are measured in kilogram per meter square (kg/m^2).

ALOHA is a computer program designed especially for use by people responding to chemical accidents, as well as for emergency planning and training. In ALOHA, the

levels of concern (LOC) are the Emergency Response Planning Guidelines (ERPGs) and the Temporary Emergency Exposure Limits (TEELs). The differences between the two are that TEELs are temporary LOCs similar to ERPGs, and defined by the United States Department of Energy for use when ERPGs aren't available. Like ERPGs, they do not incorporate safety factors. Rather, they are designed to represent the predicted response of members of the general public to different concentrations of a chemical during an incident. The ERPGs were developed as planning guidelines, to anticipate human adverse health effects caused by exposure to toxic chemicals.

- ERPG 1 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing any mild transient adverse health effects.
- ERPG 2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.
- ERPG 3 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.
- TEEL-1 predicts irritation and other minor effects.
- TEEL-2 predicts irritating but reversible effects.
- TEEL-3 predicts serious impact, perhaps death of compromised individuals.

The ERPG and TEEL guidelines do not protect everyone. Hypersensitive individuals would suffer adverse reactions to concentrations far below those suggested in the guidelines. The ERPG and TEEL committees strongly advise against trying to extrapolate these values to longer periods of time.

Computer models of various chemical and biological simulant plumes show that airborne concentrations should dissipate at 2-3 miles from the source (EPA, 2004). However, if either chemical or biological simulants were to persist beyond the boundary of WSMR, concentrations would not be considered to be harmful or cause adverse health effects in humans

Predictions will be developed for each release to so hazardous quantities of materials do not exit the range. Based on these predictions, wind direction and velocity, a “no go” criteria will be developed for each test.

2.0 BIOLOGICAL SIMULANTS

Biological simulants have physical and chemical characteristics similar to those of weapons materials, but are non-hazardous or less hazardous to individuals and to the environment. Biological simulants would be used to simulate and track the release of materials into the atmosphere and to support the development of new monitoring and detection equipment. Dispersal patterns of simulants would be used to predict the behavior of weapons of mass destruction (WMD) with similar properties, such as anthrax, plague, or smallpox to name a few. The type of biological simulants proposed for use are classified by the Center of Disease Control and Prevention (CDC) as biosafety level 1 which are non hazardous/toxic to humans or fauna. Many of the biological simulants to be used are not laboratory samples, but are obtained by using commercially available pesticides. Prior to each test, WSMR ES will be provided a list of individual strains and/or sources of all biological simulants for review to limit potential impacts.

Bacillus subtilis var. niger (Bg).

General Information. Bg is an aerobic bacterium that commonly occurs in soils around the world. It is closely related to *Bacillus anthracis*, the biological warfare agent that causes the disease anthrax. Bg is generally not pathogenic to humans, plants or animals (United States Army, 2002b). Bg is used commercially for the production of enzymes, antibiotics, and specialty chemicals (United States EPA, 1997) and as an additive to crop soil (Tomlin, 1994). Bg is capable of colonizing plant roots and deters the growth of disease microorganisms which attack root systems (Tomlin, 1994; United States Army, 2002b).

Environmental Fate and Hazards. In rare cases, Bg has been associated with livestock abortion in which the presence of Bg has been detected in aborted fetuses of cattle. However, Bg has never been identified as the causal agent (U.S. EPA, 1997). Laboratory testing of Bg has been shown to have detrimental effects to crops in which disease states have been observed in the root systems of potato tubers (Claus and Berkeley, 1986). According to referenced sources however, naturally occurring Bg-caused plant disease is known only to have occured in Norway maple (United States EPA, 1997). Norway maple is neither a native species of WSMR nor a crop of the area. The LC_{50} for fish is greater than 400 mg/L for a 96 hour exposure, indicating low toxicity to fish. Guinea pigs exposed to greater than $6x10^6$ spores (dermal) and greater than 2×10^6 spores (inhalation) showed no ill effect. Because Bg produces antifungal and antibacterial compounds, addition of Bg to the soil may affect local soil microbial communities (United States EPA, 1997). Bg often exists in the environment in the form of dormant spores. Spores may persist in soil for long periods of time until conditions are

adequate for reproduction, usually after amendment with utilizable organic matter (United States Army, 2002b; United States EPA, 1997).

Human Hazards. In rare cases, Bg has caused infection in humans, including food poisoning, endocarditis, blood infection, eye infection, and bone infection. Infections such as these have occurred in only a handful of cases, and usually the victim was in a weakened condition. Drug users, cancer patients, and young children were found to be more succeptable (Sietske de Boer & Diderichsen, 1991). Bg produces the enzyme subtilisin, which can cause allergic reaction in some people, especially after repeated exposure (United States EPA, 1997). Release of spores into the air may cause minor skin, eye and respiratory irritation. Bg spores that have been gamma-irradiated are nonviable and have none of the human or environmental hazards listed above, except as a minor eye and respiratory irritant when handled or released into the air (ENRD, 2000).

Discussion. Because of the wide usage of Bg in industry and agriculture, the United States Environmental Protection Agency (EPA) conducted a risk assessment of Bg, in which the EPA concluded that both environmental and human risks associated with Bg are small (United States EPA, 1997). During testing at WSMR, personnel handling Bg and tracking plumes containing Bg would be at almost no risk with the use of proper personal protective equipment (PPE).

Movement of the plume across the WSMR boundary is unlikely to affect civilian populations because the concentration of Bg in the plume is likely to be very low at this point. A previous test using Bg at PHETS found between 10 and 1000 colony forming units (CFU) at single point distances of 27 km (22 mi) from impact (DIPOLE ORBIT 1).

A Hazard Prediction and Assessment Capability (HPAC) analyses were run to generate a plume model for a hypothetical release of Bg from the Capitol Peak HTD test bed (Espander, 2004 and 2006 [Appendix J]). The HPAC model, using actual weather data for the region, showed Bg concentration and extent for three areas of known habitat for the White Sands pupfish (*Cyprinidon tularosa*) downwind from the test bed (with approximate distances): Salt Creek 26 km (16 mi); Malpais Spring 16 km (10 mi), Mound Springs 10 km (6 mi), and the closest location defined as essential pupfish habitat (4.2 km [2.6 mi] from the Capitol Peak test bed) by White Sands Pupfish Cooperative Agreement (NMDGF 1994). The model indicated that surface deposition of Bg out of an airborne plume would be 1.0 x 10^{-11} kg/m^2 for all four locations, with diffusion to an even smaller concentration of 1.0 x 10^{-14} kg/m^2 over short distances from these locations (Espander, 2004 and 2006 [Appendix J]). As indicated from the model run, the amount of

Bg potentially entering these waters is exceedingly small. Bg would not have a significant effect on the White Sands pupfish or other biota in the area.

Aerial agricultural application of biological agents is usually between 16 and 30 billion international units (IU) per acre, where an IU is the quantity of Bg required to produce insect death. Unfortunately, it is not possible to directly compare the one-dimensional point measurements taken at previous tests on WSMR to two-dimensional measurements of standard agricultural Bacillus application; it is also difficult to compare CFU to international units. However, a study that applied less than the recommended dosage of Bacillus thuringiensis aerially to a 30-hectare (74 acre) area observed an average surface deposition of 20.7-26.1 CFU/cm^2 (Rodenhouse and Holmes, 1992). This implies that concentration of Bg at the DTRA test beds boundary will be comparable to the lowest commercially recommended dosages. This estimate for Bg is based on a single empirical study and is extrapolated to 90.7 kg (200 lbs) of Bg per test. It also assumes that all climatic, microclimatic, and other factors are constant between tests. In fact, concentrations of Bg in the plume are variable from test to test, so it is possible that concentrations exeeding 2000 CFU/cm^2 could persist across the WSMR boundary. However, predictions will be developed for each release to so hazardous quantities of material do not exit the range. Based on these predictions, wind direction and velocity “no go” criteria will be developed for each test.

During previous testing at WSMR, Bg strain samples were found nine months after testing had concluded. The Bg population was far below from what was expected after testing had concluded at PHETS. Prolonged exposure to various extreme desert conditions may have drastically reduced the Bg population after testing; which would explain the low recovery rate of Bg. The mean concentration of Bg found in the sample areas was 177 CFUs/gm, while in the controls two of the ten samples 16 CFUs/gm were detected. This can suggest during testing the majority of Bg was destroyed or disseminated by wind or water and germinated in those areas (Mevatec, 1998). Though Bg was found, it poses no harm to native fauna, floral, or humans.

Soil microbes have an important function in desert ecosystems as decomposers and nutrient cyclers. Some microbes facilitate the uptake of nutrients by plants. Other microbes provide natural erosion control in the form of cryptogamic crusts or other forms of soil binding (Schlesinger, 1991). Addition of Bg in large quantities over a period of time at DTRA test beds may cause changes in the natural balance of soil biota, thereby affecting decomposition rates, nutrient cycling, uptake of nutrients by plants, and rates of erosion (United States Army, 2002b).

Bacillus thuringiensis gamma bacteriophage

General Information. Presently, bacteriophage typing is a method of detection for contamination of selected strains of microorganisms in laboratories or various locations. *Bacillus thuringiensis* bacteriophage is used in diverse applications. *Bacillus thuringiensis* is found in the Bacilli group, Bacilli are an extremely diverse group of bacteria that include both the causative agent of anthrax (*Bacillus anthracis*) as well as several species that synthesize important antibiotics. In addition to medical uses, bacillus are used to test heat sterilization techniques and chemical disinfectants due to their extreme tolerance to both heat and disinfectants. Bacilli are also used in the detergent manufacturing industry for their ability to synthesize important enzymes (Bacillus).

Due to the danger of anthrax being used in biological weapons, research has been put into other methods, besides the highly controversial vaccine, to defend against the deadly disease. A recently discovered bacteriophage, the gamma phage, detects and attacks *Bacillus anthracis*, and researchers are concerned about it being used in clinical application. The bacteriophage is highly selective, and is extremely effective in lysing *B. anthracis* cells, while ignoring those of its closely related counterparts *B. cereus* and *B. thuringiensis*. The gamma phage has been over 80 % effective in treating infected mice that were in the late stages of the disease, essentially rescuing them from almost certain death.

Environmental Fate and Human Hazards. The major advantage is that Bt bacteriophage is essentially non-toxic to humans, pets, and wildlife. This high margin of safety recommends its potential use on food crops or in other sensitive sites where pesticide use can cause adverse effects. Bt-based products tend to have a shorter shelf life than other pesticides. Manufacturers generally indicate reduced effectiveness after two to three years of storage, with liquid formulations being more perishable than dry formulations. Shelf-life is greatest when storage conditions are cool, dry, and out of direct sunlight (Cranshaw, 1992).

Discussion. There is concern that anthrax will develop strains that are immune to this detection and treatment. Researchers say that this is unlikely because the only way to evade this predator would be a mutational change in cell wall structure to prevent the virus from binding, and this would kill the bacterium.

Bacillus thuringiensis var. karstaki (Bt). [CAS 68038-71-1]

General Information. Bt is an aerobic bacterium commonly occurring in soils worldwide. It is closely related to *Bacillus anthracis*, the biological warfare agent that

causes the disease anthrax. Bt is generally not pathogenic to humans or other mammals (ATCC, 2000; Swadener, 1994; Tomlin, 1994). Bt spores are commercially produced as insecticides which target moth, butterfly and beetle larvae (Tomlin, 1994). After the insect larvae ingest Bt spore endotoxins are produced which upset the ion balance within the insect gut causing the insect to stop feeding. The insect eventually dies from starvation or from body-wide infection (Tomlin, 1994; Swadener, 1994).

Environmental Fate and Hazards. Bt is toxic to the water gobie fish at concentrations greater than 400 mg/L (Tomlin, 1994). There is evidence that Bt is toxic to fathead minnows in lower concentrations than those commonly used for insecticide application, although the toxicity may have been caused by other ingredients contained in the Bt insecticide powder (Swadener, 1994). Bt is also toxic to ringneck pheasants (Swadener, 1994). The acute oral LD_{50} for rats is greater than 5000 mg/kg and for rabbits is greater than 2000 mg/kg. Bt is lethal to moth and beetle larvae at 28 mg/m^2 (Crop Protection Reference, 1995). Although no research has focused on Bt toxicity to the White Sands Pupfish (*Cyprinodon tularosa*), the fathead minnow is a reasonable equivalent. Therefore, the effects on the White Sands Pupfish will be similar to those observed with the fathead minnow (United States Army, 2002b).

Bt is a naturally-occurring pathogen that readily breaks down in the environment due to its short biological half-life. Bt is photosensitive and therefore has a very short lifetime in the soil, generally less than seven days, but under suitable conditions, it can be moderately persistent in soil with a half-life of about 4 months (Tomlin, 1994;EXTOXNET, 1996). Reports have shown of viable Bt spores persisting in soil for up to one year and on foliage for up to two years (Swadener, 1994). Bt spores are released into the soil from decomposing dead insects after they have been killed by it. Bt is rapidly inactivated in soils that have a pH below 5.1. Microbial pesticides such as Bt are classified as immobile because they do not move, or leach, with groundwater. Because of their rapid biological breakdown and low toxicity, they pose no threat to groundwater. The EPA has not issued restrictions for the use of Bt around bodies of water. It can be effective for up to 48 hours in water. Afterwards, it gradually settles out or adheres to suspended organic matter.

Human Hazards. In rare cases, Bt has caused human infection, including eye infection and allergic reaction. As with Bg, people in a weakened state are more susceptible to Bt infection (Swadener, 1994). Release of spores into the air may cause minor skin, eye, and respiratory irritation. Bt spores that have been gamma-irradiated are nonviable and have none of the human or environmental hazards listed above, except as a minor irritant

when handled or released into the air. It is unlikely for Bt to be carcinogenic (ECOTOX Database EPA, 1996).

Discussion**.** Bt is generally not hazardous to humans. Using the proper PPE, DTRA test beds test personnel exposed to Bt will be at no risk to allergic reaction or infection. As with Bg, the plume is not expected to pose a risk to the general public 27 km (16.7 mi) away from the DTRA test beds.

Unlike Bg, Bt is short-lived in soil, and therefore is not likely to affect the naturally occurring soil microbial community. However, Bt may affect insect populations near DTRA test beds and have indirect effects on those animals that rely on insects for food such as moths, butterflies and beetles that are Bt specific. Large scale aerial application of Bt has been shown to decrease population sizes of beneficial and benign insects for up to two years after use. In this same study, birds and rodents that feed on insects were observed to decrease in both body size and population size during the two year period (Swadener, 1994). In the Chihuahuan Desert ecosystem, pollinators of natural vegetation are often moths (e.g. the yucca moth is an obligate pollinator of yucca), insectivorous birds and rodents. The concentration of Bt used in agriculture application is comparable to expected Bt surface deposition out of the plume near DTRA test beds (see discussion under Bg); repeated deposition of viable Bt over a period of time may reduce the number of moths and beetles in the DTRA test beds area, thereby affecting reproductive rates for some plants and population sizes of insectivorous animals with confined feeding areas.

Previous testing at WSMR identified a Bt strain nine months after explosives testing had concluded. The soil samples collected showed a count of approximately 4700 CFUs/gm mean concentration, while the background controls was 2500 CFUs/gm. Naturally occurring Bt population are found in soils, but the difference between the concentrations of Bt in the samples and controls samples is significant possiblly due to the fact that Bt is rendered harmless after 24 hours under contact of sunlight. Although Bt was found to be present in the samples, it is relatively nontoxic to humans (Mevatec, 1998).

Clostridium sporogenes.

General Information. *Clostridium sporogenes* is widely distributed in nature and is common in the intestines of animals. It is closely related to *C. botulinum*, the bacterium which produces the toxin that causes botulism. *C. sporogenes* does not produce a toxin and is non-pathogenic, but its spores are as difficult to kill as *C. botulinum* spores. For these reasons, *C. sprorgenes* is used as a mimic of *C. botulinum* in food industry research (FSCN, 1997).

Environmental and Human Hazards. *C. sporogenes* is not pathogenic to humans or animals (U.S Army 2002b).

Discussion. *Clostridium sporogenes* is not a human or environmental hazard, nor is it expected to interact with other simulants, tracers, or taggants to form hazardous compounds or organisms. With proper PPE, test personnel exposed to *Clostridium sporogenes* would be at no risk to allergic reaction or other health threat. From the available literature there no permissible exposure level (PEL) or threshold limit level (TLV).

Erwinia herbicola (EH)

General Information. *Erwinia herbicola* has been classified as a species in the genus Enterobacter, where it is also known as *Pantoea agglomeran*. *Erwinia herbicola* is a nonpathonogenic, nonspore-forming (vegetative reproduction) bacterium that is ubiquitous in nature and generally associated with soils and plants. It has been used at Dugway Proving Grounds since 1995 as an agent of biological origin (ABO) simulant for vegetative bacterial ABOs. At the present time, it is in use by the US military as an ABO stimulant for testing defensive and protective equipment against ABO attack.

Erwinia herbicola would be used as an ABO simulant for training scenarios to simulate the presence of vegetative bacterial ABOs. Because there is no indication that it could pose a risk to either human health or the environment, the restrictions to its use would be limited to the usual and customary precautions implemented for all test and training activities.

Environmental Fate and Human Hazards. *Erwinia herbicola* may cause discomfort if inhaled at high concentrations and may cause itchy eyes. It is nontoxic and not known to be a pathogen of either plants or animals, nor is it carcinogenic (Wheeler et. al., 2002). Based on the limited exposure area and the assumption that EH is found naturally in all environments, it is not anticipated that the microgranism would elicit human impacts from dispersal (Department of the Air Force, 2003).

Discussion. Available literature on EH does not indicate that the use of EH as an ABO simulant for testing at the DTRA test beds would present a significant risk to human health.

No decisive evidence was found in the available literature to connect EH as a plant pathogen. No evidence was found in the literature to indicate that the use of EH as an

ABO simulant at DTRA test beds would pose a significant risk to native or crop plants in the area or region (Wheeler et. al., 2002).

EH is widely distributed in the environment and plays an active role in ecosystem balance. Use of EH at the DTRA test beds as a biological simulant would not pose a significant risk to the environment, personnel, or population.

Lactic Dehydrogenase (LDH)

General Information. Lactic dehydrogenase (LDH) is an enzyme that helps produce energy by converting lactic acid to pyruvic acid during the metabolic process. It is present in almost all of the tissues in the body and becomes elevated in response to cell damage. LDH level is measured in the blood (Rowson, 1975).

Environmental Fate and Human Hazards. Normal LDH levels range from 45 U/L to 90 U/L. Many diseases can cause elevations in LDH levels. Other tests are usually needed to confirm a diagnosis.

Discussion. Lactic Dehydrogenase is not a human or environmental hazard, nor is it expected to interact with other biological simulants, tracers, or taggants to form hazardous organisms. Risk of exposure to test personnel will be minimized with use of proper PPE.

MS2 bacteriophage.

General Information. MS2 bacteriophage/phage (MS2) is a class of virus that infects only bacteria. It is in the ribonucleic acid (RNA) phage group. This group is made up of small icosahedral-shaped viruses, with RNA for genetic material, that infect only F+ or “male” bacteria--bacteria with pili that enable them to transfer genetic material to other bacteria that do not have pili.

MS2 is host-specific and infects only the *Escherichia coli* bacterium. It does so by attaching to the pilus and injecting RNA into the bacterium. Injected RNA carries phage protein codes that produce MS2 proteins in the bacterium. Production of phage structural proteins and replication and packaging of phage RNA create new MS2 phages. Sufficient MS2 are created to cause the bacterium to burst and release the MS2, thereby enabling them to repeat the cycle (Wheeler et. al., 2002). MS2 has been previously used as an open air test simulant for pathogenic viruses.

Environmental and Human Hazards. MS2 is widespread in nature, being present in soil, human waste, and sewage. It has been used in past military testing at Dugway Proving

Grounds, UT. MS2 bacteriophage are viruses that are obligate parasites for bacteria. The MS2 phage is host-specific, its potential impacts on the environment are limited to the effects of its attacking and destroying the E. coli bacterium. In the absence of *E. coli*, it would not reproduce or spread in the environment (Wheeler et. al., 2002).

MS2 bacteriophage is not pathogenic to humans or animals (ATCC, 2000). MS2 bacteriophages are common soil biotic constituents. They are short-lived when subjected to ultraviolet rays in sunlight and are sensitive to desiccation. Their application to the soil surface for tests may locally reduce the number of *E.coli* host bacteria, but the overall affect to bacterial populations in the underlying soil would not be significant (Dr. William Lindemann, soil microbiologist, New Mexico State University, pers. comm., 2001 [paraphrased]). There are no known environmental impacts or adverse health effects associated with this bacteriophage.

Discussion. The MS2 phage is not regulated under any of the laws pertaining to infectious or pathogenic organisms. The MS2 bacteriophage is host-specific and infects only the *E. coli* bacterium. It cannot reproduce on any other medium and is not pathogenic on any other organism. Use of MS2 at DTRA test beds would not pose a significant threat to human health or the environment. Risk of exposure to MS2 bacteriophage by test personnel would be minimized with use of proper PPE.

Noninfectious killed influenza A virus.

General Information. Noninfectious killed influenza A virus is a virus that has been killed and cannot infect any organism.

Environmental and Human Hazards. Noninfectious influenza A virus is thought by many to be infectious even after it has been killed or could possibly recombine using another organisms genetic material to form a new mutagen or pathogen. Flu experts at the Center for Disease Control and Prevention (National Immunization Program) determined that this should not occur primarily because of the virus' inactivation period; this period sufficiently disrupts the virus genes and does not allow its genes to recombine with a live virus. In addition, inactivated viral strains cannot "revert" since they are inactivated (Kilgus, pers. Comm. 2004). By definition a killed virus is not infectious and should not be able to recombine its nucleic acid with an infectious virus. There are no environmental or human hazards from killed influenza A virus (K. Oshima, pers. comm. 2004, United States Army, 2002b). Noninfectious (killed) Influenza A Virus is killed via a radioactive source that renders DNA chains broken during the process, leaving no viable chains that would join or mutate (J. Fraher pers. comm., 2004).

Discussion. The noninfectious influenza A is not a human or environmental hazard, nor is it expected to interact with other biological simulants, tracers, or taggants to form hazardous organisms. Risk of exposure to noninfectious influenza A by test personnel will be minimized with use of proper PPE.

Ovalbumin (OV) [Cas 9006-50-2]

General Information. Ovalbumin is a yellow, odorless, glycoprotein solid found in egg whites. It is common in the environment and is a dietary staple for humans and other animals. It is stable at ambient temperatures and pressures, but is denatured at temperatures over 132.8 °F (56 °C).

Environmental Fate and Human Hazards. Although existing laws do not specifically regulate OV in the work place, sensitive individuals may develop allergic-like reactions and NIOSH recommends that precautions be taken for limiting OV exposure and screening for at-risk individuals. No significant environmental interactions or impacts have been observed or identified for OV. OV will readily decompose in the environment. No adverse environmental impacts have been recognized in connection with this material. In addition to its presence in eggs and consumption as a significant food source, OV is used in conjugo-immuno determinations and drug and pharmaceutical processing. OV has been used extensively in the past as an agent of biological origin (ABO) simulant for laboratory and field tests at Dugway Proving Grounds. OV would be used as an ABO simulant for ABOs that are produced using egg products. Precautions required for the use of OV include screening for at-risk test particiants (TP) plus the usual and customary precautions implemented for all test and training activities (Wheeler et. al., 2002).

Discussion. Ovalbumin does not appear to bioaccumulate and no adverse environmental impacts have been recognized in connection with this material at the Dugway Proving Grounds, Utah.

3.0 CHEMICAL SIMULANTS

A chemical weapon (CW) utilizes a manufacturered chemical to incapacitate, harm, or kill people. CWs rely on the deleterious physiological effects of a chemical to achieve this objective. Chemical agents used to produce smoke or flame, or as herbicides are not considered to be chemical weapons. Certain CWs can be used to kill large numbers of people, while other weapons are designed mainly to injure or terrorize. In addition to having potentially horrific effects, chemical weapons are of great concern because they are often cheaper and easier to manufacture and deliver than nuclear or biological weapons.

1, 3, 5 Trimethylbenzene (mesitylene) [CAS 108-67-8]

***General Information*.** Mesitylene is a clear, colorless liquid with a characteristic odor, and is insoluble in water. Mesitylene's production and use as a dyestuff intermediate, solvent, paint thinner, and as a UV oxidation stabilizer for plastics may result in its release to the environment through various waste streams (USNLM, 2002; Lewis 1993).

Environmental Fate and Exposure. Mesitylene is released directly to the environment as a component of gasoline and as an emission from gasoline-powered vehicles, municipal waste-treatment plants, and coal-fired power stations. If released to the atmosphere, mesitylene will exist solely in the vapor phase in the ambient atmosphere. Vapor-phase mesitylene is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals resulting in a half-life of 7 hours and nitrate radicals with half-lives of 10-67 days. Mesitylene will have low mobility in soil and volatilize from both moist and dry soil surfaces. Mesitylene should aerobically biodegrade in both soil and water. Mesitylene was not degraded in methanogenic aquifer microcosms. In water, mesitylene may adsorb to sediment or particulate matter. This compound should volatilize from water surfaces and its estimated half-lives for a model river and model lake are 3 hours and 4 days, respectively (USNLM, 2002).

Bioconcentration in aquatic organisms may occur based on bioconcentration factor (BCF) values of 23-342, measured in carp. During a single continuous 24 hour exposure at 2400 ppm mesitylene, 4 of 16 rats died in respiratory arrest, while other studies showed reduced body weight, decrease in lymphocytes. The acute inhalation LC_{50} in rats was 24 mg/m^3 for 4 hours (USNLM, 2002).

Human Hazards. The general population will be exposed to mesitylene via inhalation of ambient air, ingestion of food and drinking water, and dermal contact with vapors, food and other products containing mesitylene. Occupational exposure may occur through

inhalation and dermal contact with this compound at workplaces where it is produced or used (USNLM 2002, Mesitylene). The recommended PEL is 25 ppm (125 mg/m^3) (NIOSH, 2003). The average daily dose of mesitylene from breathing air in the Netherlands was estimated at 20.5 ug/day (USNLM, 2002).

Discussion. Risk of exposure to mesitylene by test personnel will be minimized with the use of PPE. Based on a plume model, it shows the level of a predicted concentration and exposure in the proposed area (Figure 3-1). Given that the tests to be conducted are not continuous, mesitylene will have little or no impact to the surrounding human population(s).

Mesitylene could have growth and toxic effects to small mammals, based on the low doses which resulted in the LC_{50} values. Due to its low solubility, it could potentially bioaccumulate and absorb to the soil, but would not likely leach into the groundwater.

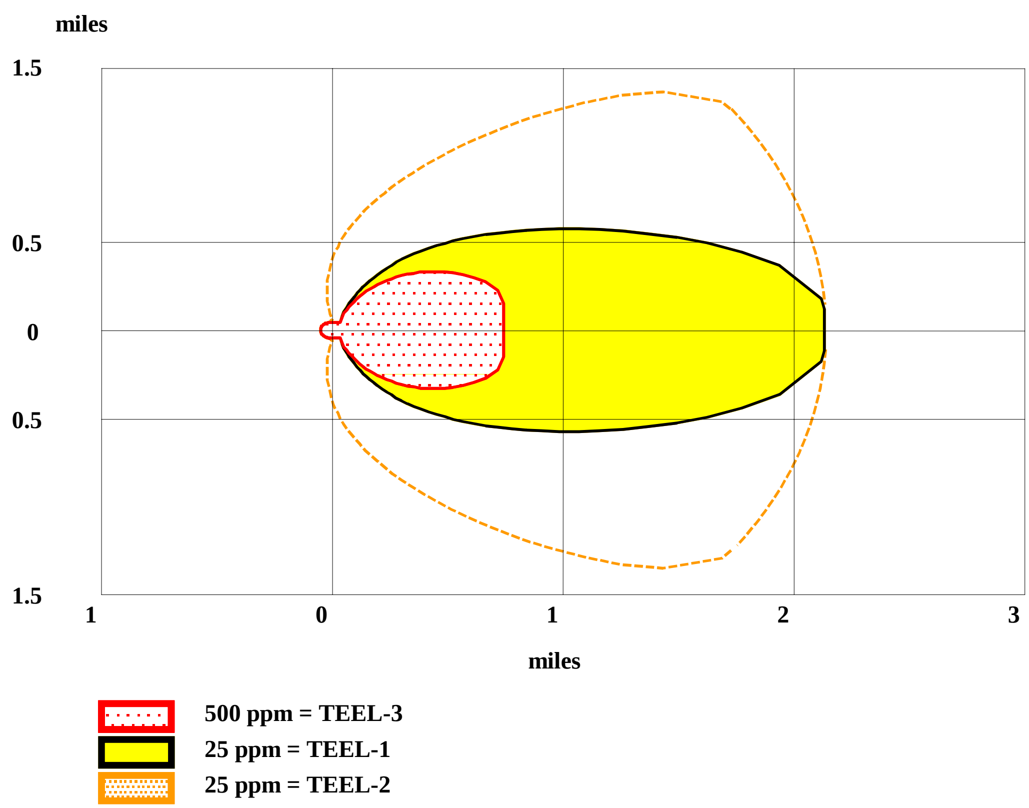

Figure 3-1. Predicted plume model for 1, 3, 5 Trimethyl-benzene (mesitylene) (ALOHA, 2004).

Bis (2-ethylhexyl) hydrogen phosphite (Bis) [CAS 3658-48-8]

General Information. Between 0.1 and 1.0 million pounds/year of bis(2-ethylhexyl) hydrogen phosphite are produced in the United States. It is used by industry as a lubricant additive, intermediate, and adhesive. Other industrial uses include corrosion inhibitor, antioxidant, textile finishing agent, and chemical intermediate for organic phosphorous compounds (USNLM, 2003)

Environmental Fate and hazards. The suspected low water solubility of bis (2-ethylhexyl) hydrogen phosphite suggests that it will sorb to soils. Hydrolysis should be as fast as that predicted for aquatic systems; that is, a half-life in the order of weeks. Since bis (2-ethylhexyl) hydrogen phosphite is considered to have a low water solubility, it is expected to bioconcentrate and to adsorb to sediments. Its low vapor pressure suggest that volatilization from water will be insignificant. The estimated vapor phase half-life for bis(2-ethylhexyl) hydrogen phosphite in the atmosphere is 23 hours, however it is likely that it will be adsorbed on particulate matter in the atmosphere (USNLM, 2003).

Hazardous decomposition products are carbon monoxide, carbon dioxide and thermal decomposition which may produce toxic fumes of phosphorus oxides and/or phosphine. The low water solubility of bis (2-ethylhexyl) hydrogen phosphite suggests that it will bioconcentrate in aquatic and possibly in terrestrial organisms (USNLM, 2003). Acute oral and skin LD_{50} found in rats was 11500 mg/kg and in rabbits was 4500 mg/kg. The LC_{50} by inhalation was greater than 20000 mg/m^3 in a rat. Intraperitoneal doses on a rat and mouse resulted in a LD_{50} of 1500 and 620 mg/kg with symptoms such as somnolence or seizures.

Human Hazards. Humans may be exposed to bis(2-ethylhexyl) hydrogen phosphite from its industrial uses as a lubricant additive, intermediate, and adhesive. Routes of exposure are inhalation, ingestion, or dermal absorption. Vapor or mist is irritating to the eyes, mucous membranes, and upper respiratory tract. Bis (2-ethylhexyl) hydrogen phosphite has no established occupational exposure limit (OEL).

Discussion. Due to bis(2-ethylhexyl) hydrogen phosphites low solubility, it will not leach into the groundwater, but will adsorb to the soil. It could possibly bioaccumlate in organisms due to its low solubility. Bis (2-ethylhexyl) hydrogen phosphite is not expected to have any impact on terrestrial or aquatic environments at and near DTRA test beds.

The general population in and around the DTRA test beds will not be affected. With the use of proper protective clothing, personnel working will have minimal effects.

Diethyl malonate [CAS 105-53-3]

General Information. Diethyl malonate is a clear, colorless liquid with a fruit like odor. Diethyl malonate is only slightly soluble in water. It is used in organic compounds and as an intermediate in the manufacture of dyestuff, medicine, and spices.

Environmental Fate and Hazards. Diethyl malonate deposited in soil and foliar surfaces is rapidly lost through volatization processes. The half-lives of diethyl malonate deposited to soils were 2 hours (hrs.) for the fast component and 5 to 16 hrs for the residual material (Ligotke, M.W. et al., 1991). Hazardous products that are associated with decomposition are carbon monoxide and dioxide, irritating and toxic fumes and gases. Acute oral LD_{50} for the rat and mouse are 14900 and 6400 mg/kg, respectively. The LD_{50} for rabbit by application to the skin was 16 ml/kg. The draize test resulted in 550 mg/24 hours with mild results on rabbits (Acros Organics, 2003).

Human Hazards. Diethyl malonate is found to be a combustible liquid and vapor. It may cause eye and skin irritation and respiratory and digestive tract irritation. The primary target organs are the central nervous system. Prolonged exposure may result in dermatitis, gastrointestinal irritation with nausea, diarrhea, and narcotic effects at high concentrations (Acros Organics, 2003).

Discussion. No OEL was found for diethyl malonate in the available literature. Diethyl malonate was found to be hazardous but with the correct use of PPE, personnel would minimize any slight risk to their safety. Populations other than personnel and local animals shall be at little risk of exposure by diethyl malonate.

Diethyl malonate will possibly absorb and bioconcentrate to the soil due to its low solubility. It is unlikely it will leach into the groundwater.

Diethyl phthalate [CAS 84-66-2]

General Information. Diethyl phthalate is a colorless liquid that has a bitter, disagreeable taste. This synthetic substance is commonly used to make plastics more flexible such as toothbrushes, automobile parts, tools, toys, and food packaging. Diethyl phthalate can be released fairly easily from these products, as it is not part of the chain of chemicals (polymers) that makes up the plastic. Diethyl phthalate is also used in cosmetics, insecticides, and aspirin (ASTDR, 1995).

Environmental Fate and Hazards. Based on its measured vapor pressure, diethyl phthalate is expected to exist primarily in the vapor-phase in the ambient atmosphere. Vapor-phase diethyl phthalate is degraded in the atmosphere by reaction with

photochemically produced hydroxyl radicals with an atmospheric half-life of about 110 hours. Diethyl phthalate is expected to have moderate to low mobility in soil based upon experimental Koc values in the range of 320 to 1726 measured in various soils at different pH and organic carbon content. Based upon the vapor pressure of this compound, volatilization from dry soil surfaces is not expected. In water, biodegradation of diethyl phthalate is expected to occur under aerobic and anaerobic conditions with estimated half-lives of about 3 and 28 days, respectively. Diethyl phthalate is expected to adsorb to sediment or particulate matter. It is expected to slowly volatilize from water surfaces, while its estimated half-lives for a model river and model lake are 89 and 652 days, respectively. Hydrolysis is expected to occur slowly with an estimated half-life of 110 days at pH 8 (USNLM, 2003).

The potential for bioconcentration in aquatic organisms is considered high based upon an experimental BCF value of 117 measured in bluegill sunfish. Acute oral LD_{50} found in rats was 8600 mg/kg. It has been investigated as a mutagen and reproductive effector. Diethyl phthalate may be toxic to aquatic life and the LC_{50} for fish are over 100 mg/L for 96-hours (Mallinckrodt, 2001c).

Human Hazards. Occupational exposure may be through inhalation or by dermal contact at workplaces where diethyl phthalate is produced or used. The general population will be exposed to diethyl phthalate via inhalation, ingestion of food and drinking water, and dermal contact with products containing diethyl phthalate. Diethyl phthalate placed directly on the skin of rats daily for 2 years was not carcinogenic. Liver tumors were seen in mice that had diethyl phthalate placed directly on their skin daily for 2 years. This type of tumor is common in mice, and the smallest dose resulted in a similar number of tumors as the largest dose. It is not clear if diethyl phthalate will cause a similar effect in humans. Other studies of cancer in humans or animals exposed to diethyl phthalate were not available (ASDTR, 1995). The PEL is 5 mg/m^3 (NIOSH, 2003). Diethyl phthalate is not classified as a human carcinogen.

Discussion. The potential for bioconcentration of diethyl phthalate in aquatic organisms is considered high based upon an experimental BCF. Diethyl phthalate has a tendency to have low mobility through different soils based on its solubility and there exists a potential for bioaccumulation and for it to absorb to the soil. Volitization from river and lake models indicate persistence in the water environment.

Dimethyl methylphosphonate (DMMP) [CAS 756-79-6]

General Information. DMMP is a example of a organophosphonate, which is a derivative of phosphonic acid. DMMP is a chemical warfare agent precursor and is regulated by the Chemical Weapons Convention. DMMP is used in industry primarily as a flame retardant and plasticizer. DMMP is used as a sulfur mustard agent simulant in laboratory tests at Dugway Proving Grounds, UT (S. Klauser, pers. comm., 2001). Production of DMMP in the United States is between 0.2 and 2 million pounds per year; however, it is not known how much is released into the environment (NTP, 2001a).

Environmental Fate and Hazards. Abiotic degradation of DMMP occurs in both water and moist soils, where it hydrolyzes to the half ester and methanol. One estimate lists the hydrolysis half life for DMMP at 13.2 years. Other forms of DMMP degradation in the environment, such as biotic or photolytic, are unknown (Howard et al., 1986). A U.S. Army study reported that DMMP has a half-life of 60 days in the soil and a half-life of 210 days in water, suggesting that other non-hydrolysis modes of degradation are important (Howard et al., 1986). DMMP vapor has a half-life of 48 days in the atmosphere. DMMP is highly water soluble with a tendency to leach into groundwater. The EPA lists it as a water pollutant, with maximum concentration in drinking water limited to 100µg/L (United States EPA, 2000).

DMMP causes low birth weight and retarded fetal physiological development in rodents. There is some evidence that DMMP causes kidney cancer in rats (NTP, 2001a). The acute oral LD_{50} for DMMP is greater than 6810 mg/kg for mice, 8210 mg/kg for rats, and 3998 mg/kg for chickens.

Human Hazards. The U.S. Army Hygiene Agency has adopted a recommended exposure limit (REL) of 20.0 mg/m^3 (20.0 ppm), bearing in mind that this is the highest concentration recommended for continuous human exposure. A dispersal model for TEP (assumed to be essentially similar to DMMP and other chemical simulants) predicted a plume concentration of approximately 4.0 ppb after 1-1.5 hours some 20-25 km downwind (FCDSWA, 1998). Although high concentrations at the detonation site would be expected briefly after a test, levels would dissipate rapidly after the first day.

The lowest observed adverse effect level (LOAEL) for DMMP is reported at 179 mg/kg body weight/day (Rowland et al., [no date], EPA report). A 70-kg human would have to ingest over 12,000 mg of DMMP before deleterious effects are noted. This potential exposure is not conceivable in any planned test scenarios at DTRA test beds.

DMMP vapor or mist may cause eye, skin, and respiratory irritation and is listed by OSHA as a possible human carcinogen (Fluka Chemical Corporation, 2001). Reported carcinogenic potential was based on studies with rats, and amounts administered were large and occurred over an extended time period (Rowland et al., [no date], EPA report). DMMP is not approved for use in open air studies at Dugway Proving Grounds, UT because of its potential carcinogenic properties (J. Martin & S. Klauser, pers. comm., 2001) (United States Army, 2002b).

Discussion. Risk of exposure to DMMP by test personnel will be minimized with use of proper PPE. Based on previous tests employing TEP, concentrations of DMMP in plume at the WSMR boundary is expected to be approximately 0.012 mg/m^3 (0.012 ppm), which is 0.06 percent of the continuous relative exposure limit. Since the tests are not continuous and the concentration at the boundary is so small, the general population are not likely to be effected.

An HPAC model generated a plume model for a hypothetical DMMP release from the Capitol Peak HTD test bed (Espander, 2004). HPAC uses real time weather data allowing it to model plume concentrations over areas of concern such as the habitats of the White Sands pupfish (*Cyprinidon tulrosa*) at Mound Springs 10 km (6 mi); Malpais Spring 16 km (10mi); and Salt Creek 26 km (16 mi) (Appendix J-6, Figure 5). The model demonstrated that plume particulates of DMMP would be 1.0×10^{-7} kg/m^2 at all three locations, with diffusion to an even smaller concentration of 1.0×10^{-9} kg/m^2 over short distances from these locations (Espander, 2004). From previous and current plume modeling, the amount of DMMP projected is small and should not have a significant effect on the White Sands pupfish or other biota in the area.

DMMP has apparent low acute toxicity in animals based on high LD_{50} values. DMMP is moderately to highly persistent in the environment. The potential for DMMP to bioaccumulate is not known, nor are the effects of DMMP on plants and soil microbes known; therefore, it is not possible to assess the chronic ecotoxicity at DTRA test beds.

DMMP is highly water soluble and has the potential to leach into groundwater. However, it is not expected that DMMP will reach groundwater at DTRA test beds. At the DTRA test beds, depth to groundwater varies from approximately 20 to 80 m, with a thick caliche layer between surface and groundwater. This makes it unlikely that DMMP and other water soluble chemical simulants will reach groundwater. In addition, groundwater at DTRA test beds is mostly brackish (1,000-10,000 mg/L) and non-potable.

Dipropylene glycol monomethyl ether (DPM) [CAS 34590-94-8]

General Information. DPM is an organic solvent contained in household cleaners, paints, inks and dyes, hydraulic brake fluid, cosmetics, and pesticides. Annual production of DPM in the United States is between one and ten million pounds. It is not known how much DPM is released into the environment. DPM is used by the United States military as a simulant of G-nerve agents (Howard et al., 1986).

Environmental Fate and Hazards. DPM is highly soluble with a low vapor pressure, and would be expected to partition to the aquatic phase of the environment. In water, DPM would not be expected to sorb to sediments or to bioconcentrate. The main degradation mechanism in water is, in all likelihood, biodegradation, while photolysis and hydrolysis is probably insignificant (Robinson, 2004). Evaporative transfer from the water to the atmosphere is expected to be minimal. Photochemical degradation of DPM is rapid, and hence, it is very short-lived in the atmosphere (half-life of 3.4 hours). It is highly water soluble and is likely to leach into groundwater (Dow Chemical Company, 1999). DPM that is on the surface of dry soil may evaporate (Robinson, 2004). DPM degrades in soil over a period of days or months.

DPM was inhaled by rats at 500 mg/m^3 for 7 hours causing slight central nervous system depression and mild toxicity. DPM causes death to dogs at 0.5-0.6 mL/kg by intravenous exposure. DPM is moderately toxic to rabbits after chronic exposure to skin (65 doses over 90 days), with no death occurring for 3 mL/kg doses, some death at 5 mL/kg doses, and significant death at 10 mL/kg doses. Inhalation is mildly toxic in some animals after chronic exposure: 400 mg/m^3 over 7 days for monkeys, 800 mg/m^3 over 186 days for rabbits, and 1500 mg/m^3 over 184 days for rats and guinea pigs caused slight central nervous system depression, and slight liver, kidney, and lung damage. The acute oral LD_{50} for rats is 535 mg/kg and the acute dermal LD_{50} for rabbits is 950 mg/kg. The acute LC_{50} for the emerald shiner fish is greater than 150 mg/L (Dow Chemical Co., 1999).

Human Hazards. Overall toxicity of DPM to humans is low. DMP is a minor eye and skin irritant and causes respiratory irritation if vapor concentrations greater than 300 mg/m^3 are inhaled. The PEL for DPM is 100 mg/m^3 for 8 hr. exposure with immediate danger to life at 600 mg/m^3 (Dow Chemical, 1999).

Discussion. When used as a CW decontaminate, DPM is not expected to have a significant impact upon human health or the environment. DPM is moderately persistent in the environment, so is not likely to build up to high concentrations in soil. DPM is expected to evaporate in moist soil and water. Any DPM entrained into the atmosphere as an aerosol would rapidly disperse to very low levels and be subsequently degraded. Any

DPM remaining at the test site would be quickly cleaned up after the test and contained for disposal. The use of proper PPE will minimize discomfort of personnel who handle or are otherwise exposed to DPM.

DPM has low toxicity in animals, so it is not expected to directly impact animal populations at DTRA test beds. DPM is used in insecticide formulations, but information on its direct toxicity to insects could not be found. Effects of DPM on vegetation and soil microbes are not known, so it is not possible to assess effects of DPM on plants, soil microbial processes, or indirect effects on animal populations at DTRA test beds (United States Army, 2002b). Because acute and chronic human toxicity is very low for DPM, no impacts on test personnel or civilian populations are expected due to its use at DTRA test beds.

Glyceryl tributyrate (Tributyrin) [CAS 60-01-5]

General Information. Glyceryl tributyrate is clear with a bitter taste and is insoluble in water. Tributyrin is a neutral short-chain fatty acid triglyceride and diffuses through biological membranes and is metabolized by intracellular lipases (Gaschott, 2001). Its uses have been found in the food industry as a synthetic flavoring and as a solvent and plasticizer (Lewis, 1993).

Environmental Fate and Hazards. Tributyrin's estimated vapor pressure of 0.0013 mm Hg (25 ºC) indicates it will exist solely as a vapor in the ambient atmosphere. In the vapor-phase, it will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals for an estimated half-life of 1.2 days. Tributyrin does not contain chromophores that absorb at wavelengths > 290 nm and therefore would not be expected to be susceptible to direct photolysis by sunlight.

Tributyrin is expected to have low mobility in soil based upon an estimated K_{oc} of 570. Volatilization from moist soil and water surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 9.6×10^{-9} atm-cu m/mole. Tributyrin is not expected to volatilize from dry soil surfaces based upon its vapor pressure.

Tributyrin is expected to adsorb to suspended solids and sediment in the water based on an estimated K_{oc}. Moderate bioconcentration in aquatic organisms is based on a estimated BCF of 50. Tributyrin hydrolysis reactions are expected to be slow with estimated half-lives of 250 days and 25 days at pH values of 7 and 8, respectively (USNLM, 2005).

The acute oral LD_{50} for rats was 3200 mg/kg. It was found to be toxic to chickens in feeding trials and found to produce carcinomas of mammary glands and leukemia in mice (USNLM, 2005). Tributyrin may inhibit cell growth and induce cell differentiation. Differentiating agents may be effective in changing cancer cells back into normal cells (Tributyrin, 2003). Hazardous decomposition products were carbon monoxide and carbon dioxide.

Human Hazards. It may cause eye, skin, respiratory, and digestive tract irritation. The toxicological properties of this material have not been fully investigated. It is not listed as a carcinogen by OSHA, EPA, or NIOSH (Acros, 2004h). An OEL has not been established for glyceryl tributyrate.

Discussion. Glyceryl tributyrate insolubility can indicate that it will not likely leach into groundwater. It can have the potential to bioaccumlate in the environment and absorb to the soil. The effects of glyceryl tributyrate have not fully been studied, but with the use of proper safety equipment, test personnel will be at no risk of exposure to glyceryl tributyrate.

Methyl salicylate (MeS) [CAS 119-36-8]

General Information. MeS is a colorless, slightly soluble liquid. It has a distinct odor and taste of wintergreen. MeS is an organic compound that is naturally produced by some plants as an herbivore defense (Howard et al., 1986; Seskar et al., 1998). MeS is also an insect pheromone (Andersson et al., 2000). MeS, known as Oil of Wintergreen, is closely related to salicylate, the pain reliever in aspirin. MeS is produced commercially as a pain reliever in topical ointments, a flavoring agent in foods and candies, a fragrance in perfumes, an ultraviolet absorber in sunscreens, and an insecticide (NTP, 2001b; Agelopoulos et al., 1999).

Environmental Fate and Hazards. MeS is relatively short-lived in the soil and water, where it biodegrades, evaporates, or hydrolizes (S. Klauser, pers. comm., 2001; Mallinkrodt, 2000; Howard et al., 1986).

Hydrolysis half-life of MeS in water of pH 7.5 is 22 days; at pH greater than 7.5, the rate of hydrolysis increases. Hydrolysis rate in moist soil is the same as in water (Howard et al., 1986). When released into the soil, MeS is expected to readily biodegrade and leach into groundwater; however, when released into the soil, this material is expected to quickly evaporate (Mallinkrodt, 2005).

When released into water, this material is expected to readily biodegrade with a estimated half-life of 10 to 30 days. MeS has an estimated bioconcentration factor (BCF) of less than 100 and is not expected to significantly bioaccumulate (Mallinkrodt, 2005).

In the atmosphere, MeS is expected to be readily degraded by reaction with photochemically produced hydroxyl radicals. MeS may be removed from the atmosphere to a moderate extent by wet deposition. MeS is expected to have a half-life between 1 and 10 days (Mallinkrodt, 2005).

MeS is mildly toxic to mice, rats, and rabbits, with an acute oral LD_{50} of 1110 mg/kg, 887 mg/kg, and 1300 mg/kg, respectively. MeS caused mild skin and eye irritation to rabbits after a 24-hour exposure to a 500 mg dose (Mallinkrodt, 2000). MeS is not likely to bioconcentrate in fish (Howard et al., 1986). MeS was found to be severely toxic to plants after aerosol deposition on foliar surfaces of 4μg/cm^2, although plants recovered within two weeks (Cataldo et al., 1993).

Human Hazards. MeS is moderately toxic to humans when ingested. Five milliliters of concentrated MeS is equivalent to almost 22 adult aspirin tablets (Botma et al, 2001). The lowest published lethal doses of MeS for humans range from 101 mg/kg to 1480 mg/kg (NTP, 2001b). MeS is a severe respiratory, skin, and eye irritant. According to the National Toxicology Program (NTP), MeS may cause birth defects (NTP, 2001b; Mallinkrodt, 2000). Severe interaction between the drug warfarin and low dose exposure to MeS has been reported. No OEL has been established for MeS (USNLM, 2003; Mallinckrodt, 2005).

Discussion. Risk of exposure to MeS by test personnel will be minimized with use of proper PPE. Based on previous tests using TEP, concentration of MeS in the plume at the WSMR boundary is expected to be approximately 0.012 mg/m^3, so MeS is unlikely to affect the general population.

MeS is short-lived in the environment, so build-up of MeS in soil and groundwater at the DTRA test beds is not expected. MeS has a high octanol/water partition coefficient (K_{ow}) of 275.4, so it is likely to bioconcentrate in terrestrial plants and animals; this is not that surprising, considering that it naturally occurs in some plants and insects. MeS has varied effects on insects, predators of insects, and parasites of insects, either through direct toxicity or by pheromone-influenced behavior (Agelopoulos et al., 1999; Lindberg et al., 2000; Andersson et al., 2000; Drukker et al., 2000). Therefore, it is possible for MeS to impact insect populations at and near DTRA test beds. Changes in insect populations

caused by MeS could have indirect effects on those animals that rely on insects for sustenance, such as rodents, bats, and birds (United States Army, 2002b).

Propionic acid [CAS 79-09-4]

General Information. Propionic acid is a clear, oily liquid with a slightly irritating pungent odor. Propionic acid is miscible in water. Propionic acid's production and use as a feed and corn preservative, and chemical intermediate may result in its release to the environment through various waste streams. It is used to control fungi and bacteria in drinking water for livestock and poultry.

Environmental Fate and Hazards. It is released to the environment with the manufacture and use of coal-derived and shale oil liquid fuels and during the disposal of coal liquefaction and gasification and wood preserving chemical waste byproducts. Textile mills, sewage treatment facilities, municipal and industrial landfills, hazardous waste sites, and gasoline and diesel fueled engines can release propionic acid to the environment. Propionic acid will exist solely as a vapor in the ambient atmosphere. In the vapor-phase, it will be degraded in the atmosphere by reaction with photochemically produced hydroxyl radicals with an estimated half-life of 11 days. Photolysis of propionic acid is not expected to be an important fate process. Propionic acid is miscible in water and monitoring data has shown that physical removal from air by wet deposition is an important removal mechanism. Propionic acid is expected to have very high mobility in soil and monitoring data has shown that it leachs into groundwater (Howard, 1997). Propionic acid may volatilize from dry soil surfaces based upon its vapor pressure. Biodegradation is likely to be the most important removal mechanism of propionic acid from soil. Volatilization from soil and water is not expected to be of great importance. In water, propionic acid is not expected to adsorb to suspended solids and sediment in water. Hydrolysis is not expected to occur due to the lack of hydrolyzable functional groups (Howard, 1997).

The acute oral LD_{50} for rats was 2500 mg/kg, mouse 5100 mg/kg. The acute LD_{50} when applied to rabbit skin was 500 mg/kg (Propionic Acid, 2001). A LC_{50} on the *Pimephales promelas* (fathead minnow) was 4740 mg/L/96 hour (USNLM, 2003).

Human Hazards. Occupational exposure to propionic acid may occur through inhalation and dermal contact with this compound at workplaces where propionic acid is produced or used. The general population may be exposed to propionic acid via inhalation of ambient air, ingestion of food and drinking water, and dermal contact with this compound and other consumer products containing propionic acid. The PELs for propionic acid is

10 ppm (30 mg/m^3) (NIOSH, 2003). Effects associated with proionic acid through inhalation are coughing and sneezing. Through dermal absorption, it may cause severe irritation and burns (Mallinckrodt, 2001d). It is not a carcinogen by NTP,or OSHA (NTP, 2005; OSHA, 2004).

Discussion. Propionic acid is not expected to effect the general population within the surrounding areas. Given the low LD_{50} for toxicity in animals, there would be minimal impacts to the fauna populations. Test personnel exposed to propionic acid would be at no risk if proper protective equipment is used properly.

Propionic acid is not expected to absorb to the soil due to its high mobility in it, however it has a potential of leaching into the groundwater, but due to the amounts being tested it is unlikely that it would reach the groundwater. It would mostly likely volatilize in the air because of its vapor pressure.

Thiodiglycol (TDG) [CAS 111-48-8]

General Information. TDG is a syrupy, colorless liquid with characteristic odor. TDG is soluble in acetone, alcohol, chloroform, and water. It is slightly soluble in benzene, carbon tetrachloride, and ether (Lewis, 1993). TDG is a hydrolysis product of sulfur mustard chemical warfare agent (HD). It is produced commercially for use in inks and dyes, antifreeze solutions, and is used as a costabilizer in the production of polyvinylchloride (Munro et al., 1999). TDG is used by the United States military as a simulant of HD.

Environmental Fate and Hazards. TDG is water soluble and has the potential to leach into groundwater. TDG does not photolyze, and hydrolysis rates are extremely slow (Munro et al., 1999). TDG may biodegrade in soil where at least one of two strains of bacteria is present (*Alcaligenes xylosoxidans* and *Pseudomonas pickettii*). However, biodegradation rates are not fast, ranging from no biodegradation to 6.26×10^{-6} mol/L/hr., depending on soil type (Lee and Allen, 1998).

Acute toxicity of TDG in rats and guinea pigs is low, with an oral LD_{50} of 6610 mg/kg and 3960 mg/kg, respectively. External exposure of 500 mg TDG to rabbits caused moderate eye irritation and mild skin irritation. Chronic toxicity in rats is also low, where 5000 mg of TDG/kg/day over 90 days resulted in mild body weight change and mild kidney damage. Small bluegill sunfish exposed to 1000 mg/L for 42 days showed no effects, suggesting that TDG is nontoxic to aquatic organisms. Likewise, TDG appears to be nontoxic to plants, as aerial application of 1 lb TDG/acre showed no effect on crop plants. TDG showed no toxic effects on soil microbes. The low K_{ow} values (<2) indicate

low potential to partition to the lipid phase in organisms, which shows little potential for bioconcentration (Munro et al., 1999).

Human Hazards. There is little information on the human hazards of TDG. No OEL has been established for TDG, although it is classified as an occupational eye, skin, and mucous membrane irritant. Based on human toxicity of similar compounds and toxicity of TDG in other mammals, the recommended reference dose (RfD) value for TDG is 500 µg/kg/day (Munro et al., 1999).

Discussion. Despite the small amount of human hazard information, it appears that human toxicity of TDG is low based on the high RfD. Use of proper PPE (safety glasses and adequate ventilation) will minimize exposure of test personnel to TDG. Based on previous tests employing TEP, concentration of TDG in the plume at the WSMR boundary is expected to be approximately 0.012 mg/m^3, so civilian human populations will be at little to no risk.

Given the high LD_{50} for TDG and evidence that it has no toxic effects on plants or soil biota, TDG is not expected to have an impact on vegetation, soil microbes, or animal populations at DTRA test beds. However, TDG rates of degradation are slow to non-existent, so TDG is expected to persist in soil and has the potential to buildup in the environment at DTRA test beds with repeated use. The likelihood of TDG reaching groundwater is low because of the lack of frequent heavy rains and the depth to groundwater in the DTRA test beds area (United States Army, 2002b).

Tributyl phosphate [CAS 126-73-8]

General Information. Tributyl phosphate is colorless to yellowish liquid that is odorless, and slightly soluble in water. It is used as a plasticizer, lubricant additive, solvent, solvent extractant for metal ions, and heat exchange agent.

Environmental Fate and Hazards. Tributyl phosphate is expected to adsorb and biodegrade in the soil, however it is not expected to leach into groundwater (USNLM, 2003; Mallinckrodt, 2006). Tributyl phosphate will adsorb to sediment and particulate matter in the water column and biodegrade. In one study, 30 to 50% of tributyl phosphate degraded in a river in 4 - 7 days when the average temperature was 14.9 °C. At an average temperature of 6.9 °C, biodegradation was negligible. This material has an experimentally-determined bioconcentration factor (BCF) of less than 100. Bioconcentration is not expected to occur because tributyl phosphate is metabolized in fish. In the atmosphere, tributyl phosphate should exist primarily as a vapor and degrade with an estimated half-life of 4.9 hours (USNLM, 2003; Mallinckrodt, 2006).

The acute oral and inhalation LD_{50} for rats was 3 gm/kg and 28 gm/m^3/1-hour. The LD_{50} when applied to a rabbits skin is > 3100 mg/kg. It has been investigated as a tumorigen, mutagen, and reproductive effector (Mallinckrodt, 2006).

Human Hazards. Exposure to tributyl phosphate will be primarily occupational via dermal contact. The general population may be exposed to tributyl phosphate in drinking water and food. Inhalation causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath, headache, and mildly affect blood cholinesterase levels, which will affect central nervous system operation. If ingested, it may cause abdominal pain and vomiting. Symptoms resulting from skin contact may include redness, itching, and pain. The Immediately Dangerous to Life or Health (IDLH) for tributyl phosphate is 30 ppm, 0.2 ppm (2.5 mg/m3) (NIOSH), and 5 mg/m3 (OSHA).

Triethyl phosphate (TEP) [CAS 78-40-0]

General Information. TEP is an impurity in, and degradation product of, the chemical nerve agent GA (Munro et al., 1999). TEP is produced commercially for use as an intermediate in pesticide production, a fire retardant, and as an ethylating agent in other production processes (Howard et al., 1986; Micromedex, 1997). In 1986, the United States produced nearly 2.3 kilotons of TEP; it is not known how much is released into the environment. TEP is used by the United States military as a simulant of G-agent chemical warfare (Howard et al., 1986).

Environmental Fate and Hazards. TEP is water soluble and may leach into groundwater, where degradation rates are slow. Hydrolysis and evaporation of TEP in water and soil are insignificant modes of degradation. Evaporation of TEP is essentially non-occurring, and TEP hydrolysis half-life is 114 years (Howard et al., 1986; Micromedex, 1997). Biodegradation of TEP may occur in soil, but rates are slow (Micromedex, 1997). TEP readily degrades in the atmosphere through reaction with hydroxyl radicals; the atmospheric half-life of TEP is seven hours (Micromedex, 1997).

Acute toxicity of TEP in mice and rats is low, with acute oral LD_{50} of 1500 mg/kg and 1600 mg/kg, respectively and a lowest lethal acute inahaltion concentration of 28,000 ppm over six hours for rats (FCDSWA, 1998). The LC_{50} for fathead minnows is greater than 100 mg TEP/L over four days. A study of carp indicated that TEP will not bioconcentrate in aquatic organisms (Micromedex, 1997). TEP affects soil microbes depending on soil type at greater than 10 µg TEP/g soil. In Nickel-Tencee soil from WSMR, TEP did not affect soil microbial activity, but in Mimbres-Glendale and Yesum-Holloman soils from WSMR, soil microbial activity decreased (Giordano et al., 1992).

TEP was shown to cause a decrease in plant growth at greater than 400 mg TEP/m^2 for tomatoes, sorghum-sudangrass, and glossy privet grown on WSMR Nickel-Tencee soil (Sikora et al., 1994).

Human Hazards. No OEL has been established for TEP. The human oral lethal dose can range from 500 to 5000 mg TEP/kg of body weight. Exposure to high concentrations of TEP may cause mild cholinesterase inhibition, including an anaesthetic-like effect, muscle relaxation, and other symptoms associated with a depressed central nervous system (ECDIN, 1998).

Discussion. Toxicity of TEP in humans is low. Use of proper protective equipment will minimize exposure of test personnel to TEP. In previous tests employing 3217 and 3204 gallons of TEP at WSMR (DIPOLE JEWEL 4 & 5, respectively), the concentration of TEP in the plume was less than 0.002 mg/m^3 at a distance of 600 m from explosion site (DIPOLE JEWEL 4), and at most 0.01 mg/m^3 at a distance of 717 m from explosion site (DIPOLE JEWEL 5). Tests are proposed using 4000 gal. of TEP. Assuming that the initial amount of TEP does not affect dispersion behavior, it is estimated that surface deposition will be between 0.0024 and 0.012 mg/m^3 TEP at these distances. The amount of TEP in the plume at this point will be less than that observed at 600 m and 717 m, an extremely low concentration. Therefore, it is not expected that tests using TEP will affect the general population. This estimate for TEP is based on two empirical studies and the extrapolation to 4000 gal. assumes that all climatic, microclimatic, and other factors are constant from test to test. In fact, concentrations of TEP in the plume are variable from test to test, so it is possible that concentrations exeeding 0.012 mg/m^3 of TEP and other chemical simulants could persist across the WSMR boundary (United States Army, 2002b). However, predictions will be developed for each release so hazardous materials do not exit the range. Based on these predictions, wind direction and velocity “no go” criteria will be developed for each test.

Acute animal toxicity of TEP appears to be low, given high LD_{50} and LC_{50} values. Hence, no immediate direct effects on animal populations are expected at DTRA test beds due to use of TEP. Soil microbial activity at DTRA test beds may be affected in areas where Yesum-Holloman soil occurs. Nickel-Tencee soil, which showed no decrease in soil microbial activity after TEP application, also occurs at DTRA test beds. In these areas, no effect on soil microbes is expected. TEP is long-lived in the environment and has the potential to buildup in the soil to concentrations that may affect plant growth. In addition, chronic animal toxicity of TEP is not known, so impacts on plant and animal communities may occur with repeated use of TEP.

Triethyl phosphite (TEPI) [CAS 122-52-1]

General Information. TEPI is a chemical warfare agent precursor and regulated by the Chemical Weapons Convention. TEPI is listed as a high production volume (HPV) chemical by the EPA.

Environmental Fate and Hazards. Acute toxicity of TEPI in mice, rats, and rabbits is with oral LD_{50} of 3720 mg/kg for mice and 1840 mg/kg for rats. The dermal LD_{50} for rabbits is 2800 mg/kg. The inhalation LC_{50} for mice is 6203 mg/m^3 over six hours and for rats is 11,063 mg/m^3 over six hours (Acros Organics, 2000).

Thermal decomposition products include oxides of phosphorus, and carbon. Little is known about TEPI environmental fate. TEPI is insoluble in water, so is not likely to leach into groundwater. Modes and rates of degradation are unknown, so it is not possible to determine the persistence of TEPI in the environment.

Human Hazards. There is limited information on the human hazards of TEPI. TEPI may cause eye, skin, gastrointestinal, and respiratory irritation (Acros Organics, 2000). Because TEPI is an organic phosphorus-containing compound, it may be an acetylcholinesterase inhibitor; exposure to TEPI may cause central nervous system depression. TEPI has no established OEL.

Discussion. Based on high acute LD_{50} and LC_{50} values for rodents, it is likely that TEPI is of low acute toxicity to humans as well; although there are no OEL standards set for TEPI. Use of proper PPE will minimize exposure of test personnel to TEPI. Based on previous tests employing TEP, concentration of TEPI in the plume at the WSMR boundary is expected to be approximately 0.012 mg/m^3, so effects on civilian human populations are unlikely.

Environmental toxicity of TEPI has not been widely studied. Because TEPI is of low acute toxicity to rats, mice and rabbits, it is not expected that TEPI will impact mammal populations at DTRA test beds. Effects of TEPI on birds, fish, insects, plants and soil microbes has not been researched, so it is difficult to assess this set of environmental effects.

Triisopropyl phosphate [CAS 513-02-0]

General Information. Triisopropyl phosphate is a colorless, flammable liquid.

Environmental Fate and Hazard. Hazardous decomposition products are carbon monoxide, carbon dioxide, phosphorous oxides. To the best of manufactures knowledge

and the available literature the chemical, physical, and toxicological properties have not been thoroughly investigated (Sigma-Aldrich, 2002b).

Human Hazard. Routes of exposure are through skin adsorption and contact which may cause irritation. Eye contact may cause irritation, while inhalation and ingestion may be harmful. Triisopropyl phosphate is irritating to mucous membranes and the upper respiratory tract. No OEL was available for triisopropyl phosphate (Sigma-Aldrich, 2002b).

Discussion. Little is known about the environmental fate of triisopropyl phosphate. Rates and its modes of decomposition are unknown; at the present time it is not possible to determine the effects to the environment. Test personnel exposed to triisopropyl phosphate will be at no risk if proper PPE is used.

Trimethyl phosphite [CAS 121-45-9]

General Information. Trimethyl phosphite is a colorless, organic liquid with a distinctive, pungent odor. It is miscible with alcohol, acetone, ether, benzene, and most organic solvents, but insoluble in water (decomposes). Trimethyl phosphite is used primarily as an intermediate in the manufacture of pesticides. It is used as a fireproofing agent in textiles, an intermediate in the production of a flame retardant polymer and as a catalyst (ACGIH, 2001).

Environmental Fate and Hazards. When exposed to air, it has a half-life of 0.016 days (Martin, 2002). The acute oral LD_{50} for rats was 2500 to 2890 mg/kg and the dermal LD_{50} for rabbits was reported to be 2600 mg/kg.

Human Hazards. Exposure to trimethyl phosphite may result in pulmonary irritation or emphysema. Vapors of trimethyl phosphite may irritate or cause permanent damage to the eyes, and contact with the liquid may result in rash or skin allergies. After exposure to trimethyl phosphate, the target organs were found to be the central nervous system. In addition, exposure may lead to damage of the liver and kidneys. Workers exposed to between 0.3 and 4 ppm with occasional values as high as 15 ppm reported no adverse effects (OSHA). The recommended exposure level by NIOSH and ACGIH is 2 ppm time weighted average (TWA) ($10 mg/m^3$); none could be found for OSHA (ACGIH, 2001).

Discussion. Trimethyl phosphite is not expected to have effects on the general wildlife and human population in and around WSMR. When exposed to the ambient air its lifetime is less than a day (0.016 days). Trimethyl phosphite is insoluble and not expected to leach into the groundwater, however, it has the potential to absorb to the soil and a

potential to bioaccumulate in the soil and in aquatic environments. Test personnel exposure will be minimal due to trimethyl phosphite half-life of 0.016 day in the air and the use of proper PPE. ALOHA plume model shows the level of a predicted concentration and exposure in the proposed area (Figure 3-2). Trimethyl phosphite is expected not to affect the general public near WSMR.

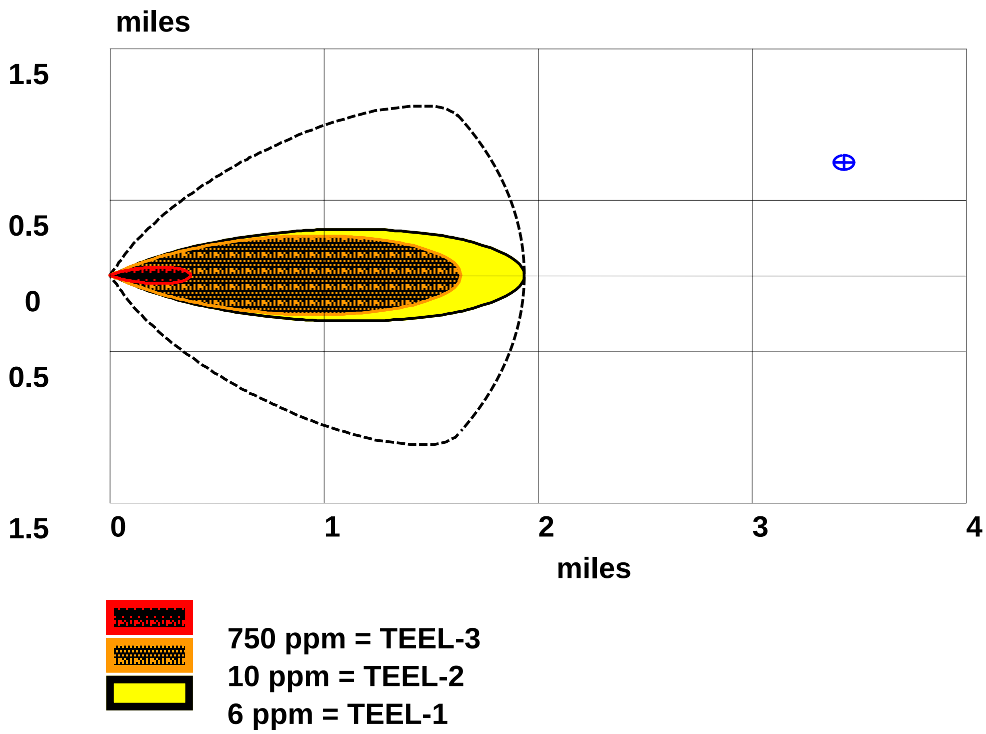

Figure 3-2. Predicted plume model for trimethyl phosphite (ALOHA, 2004).

Tripropyl phosphate (TPP) [CAS 513-08-6]

General Information. Tripropyl phosphate is used to simulate a weapons-grade chemical agent such as VX. Tripropyl phosphate is similar to mineral oil and has properties that closely resemble those of the chemical agent VX (Madeiros, 2003).

Environmental Fate and Hazards. Hazardous decomposition products are carbon monoxide and carbon dioxide while thermal decomposition may produce toxic fumes of phosphorus oxides and/or phosphine. TPP has an experimental water solubility value of 6450 mg/L (Syracuse Research Corporation, 2004). TPP has a potential to reach into the groundwater, but will not adsorb to the sediment. An experimental vapor pressure of 0.0433 mm Hg TPP should not be volatile or of concern to the surrounding environment (Syracuse Research Corporation, 2004). TPP has a low vapor pressure of 0.043 mm Hg and would not vaporize readily to be dispersed in the atmosphere. Its specific gravity of

1.012 relative to water indicates it is only slightly soluble in water, thus any spillage or deposition on water bodies would lead to minimal amounts being dissolved in the water and most of the TPP would sink and be associated with bottom deposits. A search of relevant information sources for TPP has not produced information pertaining to the environmental fate of this material. From comparison with properties for other organophosphorus compounds, TPP is expected to eventually be degraded by biological and/or chemical reactions to orthophosphate (Shipley, 2003). Based on observations from the environmental fates of TEP and TBP, two closely related compounds, the following properties have been estimated for TPP. It would have an atmospheric half-life of 5 to 7 hrs. It would biodegrade and hydrolyze slowly in water and may biodegrade in soil.

Human Hazards. Multiple exposure routes may be harmful, including: inhalation, ingestion, or skin absorption. Vapor or mist is irritating to the eyes, mucous membranes, and upper respiratory tract. To the best of the manufacture's knowledge and available literature, the chemical, physical, and toxicological properties have not been thoroughly investigated (Sigma-Aldrich, 2002e). It is not known if tripropyl phosphate is a carcinogen nor is there an established OEL found in the available literature.

Discussion. Regardless of the limited amount of information on tripropyl phosphate, the use of proper PPE will minimize exposure of test personnel to tripropyl phosphate. The general population in the areas of the test beds would be at little or no risk from tripropyl phosphate due to the minute amounts being used.

Tripropyl phosphate has a potential to leach into the groundwater; however, it would not absorb to the sediment. It is unlikely that it will bioaccumulate in the environment due to its high water solubility.

4.0 RADIOLOGICAL SIMULANTS

Radiological simulants are non-radioactive but contain some of the same chemical elements that can be used in radiological dispersion devices, so-called “dirty bombs”. (The term “dirty bomb” refers to an explosive device that contains radioactive materials intended to cause harm from physical dispersal rather through a nuclear fission reaction).

Cerium dioxide (CeO_2) [CAS 1306-38-3]

General Information. Cerium dioxide is whitish, odorless powder. It is commercially a hydrated oxide containing 85 to 90 % ceric oxide. It is known as ceric oxide and as cerium hydrate. Ceric oxide is soluble in concentrated mineral acids and insoluble in water. It is used in the production of cerium salts and ceric oxides, opacifier in glasses and enamels (imparts yellow color), and shielding glass (Lewis, 1993).

Environmental Fate and Hazards. The acute oral LD_{50} for rats was greater than 5 g/kg. Hazardous decomposition products are carbon monoxide and carbon dioxide and irritating and toxic fumes and gases,

Human Hazards. Cerium dioxide is a mild irritant to the eye and skin. If ingested, it may cause gastrointestinal irritation with nausea, vomiting, and diarrhea. It is expected to be a low ingestion hazard from the available information. Cerium dioxide is not listed as a carcinogen by EPA, OSHA, or NIOSH. There are no OEL’s for cerium dioxide from the available literature. Compounds of cerium and other rare earth elements are generally of low toxicity. The greatest exposures are likely to be during the manufacture of cerium.

Cesium chloride (CsCl) [CAS 7647-17-8]

General Information. Cesium chloride forms colorless crystals and is odorless. Cesium chloride is soluble in water and alcohol, but insoluble in acetone. It is used in brewing, other cesium compounds, and mineral waters. Other uses are evacuation of radio tubes (positive ions supplied at surface of filaments), fluorescent screens, and contrast mediums (Lewis, 1993).

Environmental Fate and Hazards. The acute oral LD_{50} for mice was 2300 mg/kg. It is being investigated as a mutagen and reproductive effector. Hazardous decomposition products are oxides of the contained metal and halogen, possibly also free, or ionic halogen (Mallinckrodt, 2003).

Human Hazards. It is found to be an eye, skin, and respiratory irritant. If ingested in large concentrations, it may produce gastrointestinal disturbances. Cesium chloride

permissible exposure level (PEL) is 15 mg/m^3 (Total Dust-IOSHA). It is not listed as a carcinogen by the EPA and NTP (Mallinckrodt, 2003;U.S. Department of Health and Human Services, 2002).

Manganese dioxide (MnO_2) [CAS 1313-13-9]

***General Information*.** Manganese dioxide is gray lumps or fine, black to brownish-black powder that is odorless. Manganese dioxide is insoluble in water and soluble in hydrochloric acid. It is used as an oxidizing agent, depolarizer in dry cell batteries, pyrotechnics, and matches. It is used as a catalyst in laboratory, textile dyeing, and is a source of metallic maganese (as pyrolusite) (Lewis, 1993).

Environmental Fate and Hazards. The acute oral LD_{50} for rats was greater than 3478 mg/kg and is investigated as a reproductive effector. Manganese metal is known to damage the reproductive system and has shown teratogenic effects in laboratory animals. Hazardous decomposition products are toxic metal fumes may form when heated to decomposition. Modes and products of manganese dioxide degradation in soil, air, and water were not available. However, based on its insolubility it could adsorb to soil and sediment and bioaccumulate. It would not likely leach into the groundwater because of its insolubility.

Human Hazards. Manganese dioxide is an oxidizing agent and may ignite organic matter. Inhalation can cause a flu-like illness (metal fume fever). This 24- to 48-hour illness is characterized by chills, fever, aching muscles, dryness in the mouth and throat and headache. If inhaled, it may irritate the respiratory tract and increase the incidence of upper respiratory infections (pneumonia). Absorption of inorganic manganese salts through the lungs is poor but may occur in chronic poisoning. When ingested, it may cause abdominal pain and nausea. It is poorly absorbed through the intestines, inorganic manganese salts may produce hypoglycemia and decreased calcium blood levels should absorption occur. Chronic manganese poisoning can result from excessive inhalation and ingestion exposure and involves impairment of the central nervous system. Early symptoms include sluggishness, sleepiness, and weakness in the legs. Advanced cases have shown fixed facial expression, emotional disturbances, spastic gait, and falling. Illness closely resembles Parkinson’s disease. Kidney effects, blood changes and manganese psychosis also may occur as a result of chronic exposure. Chronic inhalation exposure can cause lung damage. Persons with impaired respiratory function, psychiatric or neurological disturbances, and nutritional deficiencies may be more susceptible to the effect of this substance. EPA, OSHA, and NIOSH do not consider manganese dioxide a carcinogen. PELs are 5 mg/m^3 (ceiling for manganese compounds as Mn- OSHA) and 0.2

mg/m^3 (TWA) (for manganese, elemental and inorganic compounds as Mn- ACGIH Threshold Limit Value (TLV)). It is not listed as a carcinogen by NTP (U.S Department of Health and Human Services, 2002).

Strontium titanate ($SrTiO_3$) [CAS 12060-59-2]

General Information. Strontium titanate is a white-gray odorless powder and is insoluble in water and most solvents. It is used in electronics and electrical insulation (Lewis, 1993). Nanocrystalline $SrTiO_3$ is made by synthesizing hydrothermal treatment of nanocrystalline titanium dioxide in the presence of strontium hydroxide. Working photoelectrochemical solar cells are produced using these nanometer-sized semiconductor particles as photoelectrode materials (Burnside, 1999).

Environmental Fate and Hazards. Hazardous decomposition products produced are toxic fumes such as strontium oxides and titanate oxides. There is inadequate data on which to classify the agent in terms of it's carcinogenicity in humans and/or animals.

Human Hazards. Strontium compounds have a low order of toxicity. It is chemically and biologically similar to calcium. The oxides and hydroxides are moderately caustic materials. For titanium compounds, they are found to be physically inert. There are no reported cases in the literature where titanium as such has caused intoxication. The dust from titanium is an eye and skin irritant. The PEL for strontium titanate is 0.5 mg/m^3 (OSHA). It is not listed as a carcinogen by EPA, OSHA, NTP, or NIOSH (U.S Department of Health and Human Services, 2002; Dierks, 2003; NIOSH, 2004).

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5.0 TRACERS AND TAGGANTS

Taggants and tracers are materials sometimes released with the simulants to help in the tracking of the plume path over substantial distances. Taggants selected for use on WSMR (such as diethyl phthalate, diatomaceous earth, gold dust, and silica glass beads), are materials not found in nature locally and are generally used only once in a given area to obtain meaningful tracking data. Additional environmental analysis will be required for any taggants lacking existing environmental fate information. Using taggants in tests, the potential for actual weapons of mass destruction (WMD) materials to harm the human and natural environments near defeated military targets can be predicted without releasing toxic weapons material.

Bas-Oil red dye

General Information. Bas-Oil red dye is used for dye for silks, cotton, and wool, as well as for papers, leather, and plastics. It is a component of C.I. Solvent Red. It is used in water pollution studies as a tracing agent and adsorption indicator. Production in the United States is an estimated 4.54 million gallons per year. (Based on Rhodamine 6G (CAS 989-38-8) a component of Bas-Oil red dye) (USNLM, 2003).

Environmental Fate and Hazards. Rhodamine 6G is a specific inhibitor of aerobic growth of yeast (*Saccharomyces cerevisiae*), and isolated rhodamine-6G-resistant mutants have been used to demonstrate extrachromosomal inheritance in yeast (USNLM, 2003). Bas-Oil red dye is insoluble in water. Due to insolubility it is likely to absorb to soil and bioaccumulate. Bas-Oil red dye is not likely to leach to the groundwater.

Human Hazards. Sufficient evidence has not been found to classify it as a human carcinogen. Rhodamine dyes are important causes of occupational phototoxic or photoallergic reactions (USNLM, 2003). An OEL has not been established or found in the existing literature.

Discussion. There is insufficient human evidence found on Bas-Oil red dye. Bas-Oil red dye is non-toxic and will mostly likely be an irritant. It will not affect the general population. Proper safety equipment will minimize the exposure and effects. From the available literature, Bas-Oil red dye will not affect the wildlife. Bas-Oil red Dye could possibly persist in the environment by accumulation and absorption.

Carbon tetrafluoride (CF_4) [CAS 75-73-0]

General Information. CF_4 is a colorless and odorous gas. and CF_4 is a perfluorocarbon gas (PFC) that is used in semi-conductor processing and aluminum production

(Sematech, 1994; EIIP, 1999). It is also known as Halon 14, which is used as a fire suppressant, and Freon 14, which is used as a refrigerant (Lewis, 1992a). Approximately 27,000 metric tons of CF_4 are released annually into the atmosphere worldwide by the aluminum industry alone (EIIP, 1999; Sematech, 1994). PFCs, including CF_4, are greenhouse gases that trap infrared energy emitted from the earth (Sematech, 1994); atmospheric release of CF_4 is monitored by the EPA. CF_4 is used by the United States military as a tracer gas in plume modeling studies.

Environmental Fate and Hazards. In air, vapor-phase CF_4 is expected to be degraded very slowly in the ambient atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be >110 years. CF_4 is exceedingly inert photochemically, with no absorption at wavelengths longer than 110 nm. CF_4's estimated atmospheric lifetime ranges from 10,000 years to 50,000 years. (UNNLM, 2003; Sematech, 1994).

In soil, CF_4 is expected to have high mobility based upon an estimated K_{oc} of 100. Volatilization from wet and dry soil surfaces is expected to be an important fate process based upon a Henry's Law constant of 5.15 atm-cu m/mole and this compound's vapor pressure.

In water, CF_4 is not expected to adsorb to suspended solids and sediment in the water column based upon the estimated K_{oc} of 100. CF_4 is expected to volatilize rapidly from water surfaces based upon its Henry's Law constant. The estimated volatilization half-live for an river and lake model are 2.7 hours and 3.7 days, respectively. The potential for bioconcentration in aquatic organisms is low based upon a BCF of 1.6. Highly fluorinated compounds such as CF_4 are not expected to biodegrade rapidly. CF_4 is not expected to hydrolyze due to the lack of hydrolyzable functional groups.

CF_4 is essentially non-toxic, with an acute inhalation LC_{50} of 895,000 ppm for a 15 minute exposure to rats. CF_4 is inert, and generally poses no health or environmental risk, except as a global warming agent (EIIP, 1999).

Human Hazards. Exposure to CF_4 may come through inhalation or dermal contact. CF_4 in liquid form may cause frostbite to exposed tissue due to rapidly volatilizing liquid and vapor. Because CF_4 gas is heavier than air, it may displace oxygen in non-ventilated areas, causing headache, dizziness, anesthesia, drowsiness, and other symptoms of oxygen deficiency. It may cause hypoxia with dizziness, disorientation, incoordination, narcosis, nausea, and vomiting. Liquid splashed in the eye may cause freezing resulting in frostbite, temporary irritation or serious damage. Ingestion of a gas is unlikely. Skin

contact with the liquid may cause irritation or frostbite. No OELs have been established. It is not a known carcinogen by either NTP, OSHA or NIOSH (BOC Gases, 2005).

Discussion. Test personnel exposed to CF_4 will be at no risk if proper PPE is used. CF_4 is not expected to have any impact on the general population. CF_4 is not expected to have any impact on terrestrial or aquatic ecosystems at and near DTRA test beds.

2-Diethylaminoethanethiol hydrochloride [CAS 1942-52-5]

General Information. 2-diethylamino ethanethiol hydrochloride is a light, beige solid with a stench. 2-diethylaminoethanethiol hydrochloride is soluble in water and alcohol and insoluble in benzene. It is used as a pharmaceutical intermediate, and pesticide polymerization promoter (Lewis, 1993).

Environmental Fate and Hazard. Hazardous decomposition products are hydrogen chloride, nitrogen oxides, carbon monoxide, irritating and toxic fumes and gases, carbon dioxide and nitrogen. The acute intraperitoneal LD_{50} for mice was 100 mg/kg (NTIS, no date).

Human Hazard. Routes of exposure are eye contact, inhalation, ingestion, and skin adsorption. Symptoms associated with eye exposure are irritation, chemical conjunctivitis. Ingestion may cause gastrointestinal irritation with nausea, vomiting, and diarrhea. Inhalation may cause respiratory tract irritation and may produce delayed pulmonary edema. The toxicological properties of this material have not been fully investigated (Acros Organics, 2003). No OEL has been established for 2-diethylamino ethanethiol hydrochloride.

Discussion. Environmental toxicity of 2-diethylaminoethanethiol hydrochloride has not been widely studied; therefore, it is not possible to assess the toxicity at the DTRA test beds.

Test personnel exposed to 2-diethylaminoethanethiol hydrochloride will be at no risk if proper PPE is used. 2-diethylaminoethanethiol hydrochloride is not expected to have any impact on general population.

2-(Diisopropylamino)-ethanethiol hypochloride [CAS 41480-75-5]

General Information. 2-(diisopropylamino)-ethanethiol hypochloride, this chemical appears as a moist white to off-white powder.

Environmental Fate and Hazard. Hazardous decomposition products are nitrogen oxides, carbon monoxide, carbon dioxide, nitrogen, sulfur oxides (SO_x, including sulfur oxide and sulfur dioxide). It is a hydrolysis product of the nerve agent VX.

Human Hazard. If exposed to the eye, skin or ingested or inhaled may causes irritation and chemical conjunctivitis. It may cause gastrointestinal irritation with nausea, vomiting, and diarrhea when ingested. It may produce delayed pulmonary edema and irritation to the mucous membrane and upper respiratory tract. No OEL has been established nor is it listed as a carcinogen by NIOSH, OSHA, or NTP (Arcos Organics, 2002).

Discussion. Environmental toxicity of 2-(diisopropylamino)-ethanethiol hypochloride has not been widely studied. Test personnel exposed to 2-(diisopropylamino)-ethanethiol hypochloride will be at no risk, if PPE used. 2-(diisopropylamino)-ethanethiol hypochloride is not expected to have any impact on the general population.

Dysprosium Oxide [CAS 1308-87-8]

General Information. Dysprosium oxide appears as a white powder and is soluble in acids and alcohol. Dysprosium oxide is the main raw material for dysprodium metal, which is widely used in Neodymium-Iron-Boron magnets. It is also has specialized uses in ceramics, glass, phosphors, lasers and dysprosium metal halide lamp. Highly pure dysprosium oxide is used in the electronics industry as an antireflection coating in photoelectric devices (Metal Rare Earth, 2004). Other uses include of dysprosium oxide are in cermets used in nuclear reactor control rods that do not require water cooling (Lewis, 1993).

Environmental Fate and Hazards. Hazardous decomposition products have not fully been investigated other then irritating and toxic fumes and gases. The acute oral LD_{50} for a rat was greater than 5 g/kg.

Human Hazards. The toxicological properties of this material have not been fully investigated. It may cause eye and skin irritation, and respiratory and digestive tract irritation. The PELs are 15 mg/m^3 (OSHA) and 10 mg/m^3 (ACGIH). It is not considered a carcinogen by OSHA, NTP, and NIOSH.

Discussion. Environmental toxicity of dysprosium oxide has not been widely studied. Effects of dysprosium oxide on birds, fish, insects, plants and soil microbes has not been researched, so it is difficult to assess this set of environmental effects.

Risk of exposure to dysprosium oxide by test personnel will be minimized with use of proper PPE. Modes and products of dysprosium oxide degradatation in soil, air, and water were not available.

Fluorescein [CAS 2321-07-5]

General Information. Fluorescein appears as an orange-red, crystalline powder. Very dilute alkaline solutions exhibit intense greenish–yellowish fluorescence by reflected light, while the solution is reddish-orange by transmitted light. Fluorescein is soluble in dilute alkalies, boiling alcohol, ether, dilute acids, and glacial acetic acids. It is insoluble in water, benzene, and chloroform. It is used in dyeing seawater for spotting purposes, tracer to locate impurities in wells, dyeing silk and wool, and diagnostic aid in ophthalmology, indicator and reagent for bromine (Lewis, 1993).

Environmental Fate and Hazards. Lethal dose administered orally to rabbits was 2500 mg/kg. Acute intravenous LD_{50} for mouse was 300 mg/kg for fluorescein. Hazardous decomposition products are carbon dioxide and carbon monoxide that may form when heated to decomposition.

Human Hazards. Fluorescein is nontoxic, and has been approved for use in external cosmetics in the United States by the Food and Drug Administration (Adams, not listed). Routes of exposure are through inhalation, ingestion, and eye or skin contact may cause irritation to sensitive individuals. No OEL have been established and it is not known if it is a carcinogen.

Discussion. Environmental toxicity of fluorescein has not been widely studied. Because fluorescein is of low acute toxicity to mice and rabbits, it is expected that fluorescein will possibly impact small mammal populations at DTRA test beds.

Risk of exposure to fluorescein by test personnel will be minimized with use of proper protective equipment.

Fluorescein will not leach into the groundwater, however it has the potential to absorb to the soil based on its insolubility. Fluorescein also has the potential to bioaccumulate.

Forane 134a (HFC-134a) [CAS 811-97-2]

General Information. Forane 134a is a trade name for HFC-134a. HFC-134a is a hydrofluorocarbon gas used as an alternative for chlorofluorocarbons (CFC), which are ozone-depleting gases. HFC-134a has an ozone depleting potential of zero thus it will not deplete the ozone (USEPA, 2004). HFC-134a is used commercially as a refrigerant in

automotive air conditioning, supermarket refrigerator cases, and household refrigerators. In addition, HFC-134a is used in polymer foam blowing and aerosol products (DuPont, 1997). In 1999, total global production of HFC-134a was 133,662 metric tons, with 71,800 metric tons released into the atmosphere. Since 1990, a total of 237.8 metric tons of HFC-134a been released into the atmosphere worldwide (AFEAS, 2000). Because of its low toxicity, non-flammability, and its non-reaction with ozone, HFC-134a is used as a tracer gas for plume modeling studies conducted by the U.S. military.

Environmental Fate and Hazards. HFC-134a is only slightly water soluble, so is not likely to leach into groundwater. HCF-134a gas readily mixes with the atmosphere. In the atmosphere, HFC-134a gas degrades to trifluoroacetic acid through reaction with hydroxyl radicals (Peterson et al., 1999). When exposed to high temperatures, as from an explosion, HFC-134a degrades to hydrogen fluoride (DuPont, 1997).

The acute inhalation LC_{50} for rats is greater than 500,000 ppm for a four-hour exposure, suggesting that HFC-134a is essentially nontoxic. Acute external exposure over a 24-hour period caused slight eye and skin irritation to rabbits. A chronic toxicity study of HFC-134a on guinea pigs showed no allergic reaction after repeated skin exposure and no effects on rats after repeated external and oral exposure over a six-week period. Bioaccumulation of HFC-134a does not occur in rats (Elf Atochem, 1999).

Human Hazards. HFC-134a is practically nontoxic to humans, but in very high concentrations may cause eye and respiratory irritation. HFC-134a in liquid form may cause frostbite to exposed tissue due to rapidly volatilizing liquid and vapor. Because HFC-134a gas is heavier than air, it may displace oxygen in non-ventilated areas, causing headache, dizziness, anesthesia, drowsiness, and other symptoms of oxygen deficiency (Elf Atochem, 1999). The TLV for HFC-134a is 1000 ppm (4240 mg/m^3).

Discussion. Test personnel exposed to HFC-134a would be at no risk if proper PPE is used. HFC-134a is not expected to have any impact on human populations outside of WSMR. Given that HFC-134a is used in its gas form for testing, and readily reacts with the atmosphere, it is not expected to have any impact on terrestrial or aquatic environments at and near DTRA test beds.

Indium oxide [CAS 1312-43-2]

General Information. Indium is widely distributed in the earth's crust in trace amounts. Indium occurs most frequently in zinc ores and zinc minerals and 95% of natural indium exists as the isotope In^{115}. Indium forms monovalent, divalent, and trivalent compounds with the trivalent compounds being the most stable and most abundant. The primary

sources of indium in the environment are from zinc smelting; to a lesser extent, from tin, manganese, tungsten, copper, iron, lead, cobalt, and bismuth smelting. Indium is used in bearings for automobiles and aircraft, in solders and low-melting alloys, and in nuclear reactor control rods. Indium oxide is used for electrically conductive and heat reflective applications such as Liquid Crystal Displays (LCD), low pressure sodium lamps, and used for coloring glass. Indium oxide is white to light colored powder in both amorphous and crystalline forms. It is soluble in hot acid (amorphous) (Lewis, 1993). Indium consumption in the United States was an estimated 85 metric tons in 2002 (Jorgenson, 2004).

Environmental Fate and Hazards. Indium has a half-life of $4.4 \times 10^{+14}$ years and decays by beta-ray emission. Monovalent and bivalent indium compounds tend to disproportionate into the trivalent compounds and indium metal; the trivalent compounds are most stable. Indium compounds are expected to exist in the particulate phase in the ambient atmosphere. Particulate-phase indium may be physically removed from the air by wet and dry deposition.

In an aquatic environment, indium is predicted to adsorb to suspended solids and sediment in water. The oxides and hydroxides of indium are purely basic and are not expected to undergo hydrolysis (USNLM, 2002). The acute oral LD_{50} for indium powder was 4200 mg/kg for rat.

Human Hazards. The information available on the toxic properties of indium in humans is limited. It is known that soluble indium salts are extremely toxic when injected into laboratory animals with a direct effect on the heart, liver, kidneys and blood. However, indium salts are far less toxic when administered orally or by inhalation. Teratogenic effects have also been reported in laboratory animals injected with indium, but its applicability to human exposure is unknown. The inhalation route is by far the most significant route in the occupational setting. No OEL has been established, although the PEL for indium and its compounds is 0.1 mg/m^3 (as In) (ACGIH, 2001). It is not a known carcinogen (Spex Industries, 1995).

Discussion. Test personnel exposed to indium oxide will be at no risk if proper protective equipment is used. Indium oxide is not expected to have any impact on the general population.

Indium oxide is not water-soluble and does not have the potential to leach into groundwater; however, indium oxide could bioaccumalate because of its insolubility in terrestrial or aquatic environments at and near DTRA test beds.

Locate Blue Dye: Trypan [CAS 72-57-1] and C.I. Direct Blue 15 [CAS 2429-74-5]

General Information. Locate blue dye varied by different manufacturers and chemical abstracts service (CAS) registry numbers. Trypan and C.I Direct Blue 15 are examples of two types of blue dyes. Blue dye is used as a staining compounds in textiles, leather and paper products, and as a stain for biological preparations. It is used in the military as a smoke obscurant.

Environmental Fate and Hazards. Trypan is released in the environment, its fate is not fully known. In soil, it is unknown whether trypan blue will adsorb to the soil; however, trypan blue has been included in a list of readily water soluble dyestuffs which suggests that the compound will not adsorb to soil. It may be subject to rapid biodegradation in soil under anaerobic conditions based upon aqueous anaerobic screening test data with anaerobic sludge inocula. It is unknown whether it will be susceptible to biodegradation under aerobic conditions in soil or water. As a tetrasodium salt of a tetrasulfonic acid, trypan blue will not be expected to volatilize from moist near-surface soil. If trypan blue is released to water, it may be subject to rapid biodegradation under anaerobic conditions based upon aqueous anaerobic screening test data with anaerobic sludge inocula; 4, 4'-diamino-3, 3'-dimethylbiphenyl was identified as a metabolite. It is unknown whether trypan blue will bioconcentrate in aquatic organisms or adsorb to sediment and suspended particulate matter; however, trypan blue has been included in a list of readily water soluble dyestuffs which suggests that the compound will not bioconcentrate in aquatic organisms or adsorb to sediment and suspended matter. As a tetrasodium salt of a tetrasulfonic acid, trypan blue will not be expected to volatilize from water. Although it has been reported that trypan blue absorbs light at wavelengths in the range of 584 to 617 nm depending on the formulation used, no information was found which indicates that the compound photogrades. As a tetrasodium salt, trypan blue is expected to exist as a particulate in the ambient atmosphere. Particulate-phase trypan blue may be physically removed from the air by wet and dry deposition (USNLM, 2003). Trypan studies have shown to cause abnormalities in rats, mice, and hamsters such as lose in weight, cardiac, breating abnormalities. Tumorgenic evidence was found in these studies leading to it causing cancer in humans. The acute oral LD_{50} for a rat was 6200 mg/kg.

The ionic state of C.I. Direct Blue 15 makes this compound essentially non-volatile, therefore, this compound will exist solely in the particulate phase in the ambient atmosphere. Particulate-phase C.I. Direct Blue 15 may be physically removed from the air by wet and dry deposition. If released to soil, the retention of C.I. Direct Blue 15 by ion-exchange processes, particularly on clay surfaces, and adsorption at mineral surfaces such as geothite, may slow down or prevent leaching. The volatilization of the dye from

soil surfaces to air will not be important as C.I. Direct Blue 15 is an ionic compound. Based on limited data, this compound is expected to be resistant to aerobic biodegradation, however, it should readily biodegrade anaerobically. Complete anaerobic biodegradation of C.I. Direct Blue 15 was reported in 7 days using an activated sludge inoculum. The loss of the dye from water by evaporation is not expected to be an important fate process. Direct Blue 15 is expected to adsorb to sediments and particulate matter in water due to ionic processes with adsorption increasing with decreasing pH.

Human Hazards. Occupational exposure to trypan blue or any other dye may occur at workplaces. Trypan blue is a tetrasodium salt of a tetrasulfonic acid, which is used as a dye; exposure to the trypan blue will probably be either by dermal contact or inhalation. NIOSH NOES survey in 1981-1983 showed it statistically estimated that 813 workers (623 of these are female) were potentially exposed to trypan blue in the United States (USNLM, 2003). Information on the human health effects from exposure to this substance is limited. When exposed, trypan blue may cause irritation to the respiratory tract, redness and pain to the skin. When ingested, it may cause irritation to the gastrointestinal tract. No OEL has not been established and it is not a considered a carcinogen by NTP, but a potential carcinogen by International Agency for Research on Cancer based on there is sufficient evidence in animal tests, or degrees of evidence considered appropriate (Mallinckrodt Baker, 2003). The

Occupational exposure to CI Direct Blue 15 or any other dye may occur at workplaces. CI Direct Blue 15, a bis-azo dye derived from 3,3'-dimethoxybenzidine, is used mainly for dyeing textiles and paper. The technical grade contains about 50% of pure dye, in addition to inorganic salts and a mixture of about 35 organic compounds, including 3,3'-dimethoxybenzidine. CI Direct Blue 15 is used as a dye; exposure to the CI Direct Blue 15 will probably be either by dermal contact or inhalation. When exposed it may cause irritation to eyes, skin respiratory tract. Presently, there is no OEL for CI Direct Blue 15, however it has been listed as a possible carcinogen by NTP (USNLM, 2003). There is sufficient evidence in experimental animals for the carcinogenicity of CI Direct Blue 15. The overall evaluation is it is possibly a carcinogenic to humans (Group 2B) (USNLM, 2003, Mallinckrodt Baker, 2003b).

Discussion. Trypan has a apparent low acute toxicity in animals. When released into the soil, trypan blue is not expected to evaporate significantly and is not expected to leach into groundwater. When released into water, trypan is not expected to evaporate significantly. This material is not expected to significantly bioaccumulate. When released into the air, this material is not expected to be degraded by photolysis (Mallinckrodt Baker, 2003).

CI Direct Blue 15 is non-volatile and will exist in the particulate phase in the atmosphere. The volatization of this dye from soil surfaces to air will not be important as an in ionic compound. It is expected to be resistant to aerobic biodegradation, although it should readily biodegrade anaerobically. It is expected to adsorb sediments and particulate matter in water.

Malachite green [CAS 633-03-4]

General Information. Malachite green is dark, fine crystals that are soluble in water. It is produced in dyes and in the preparation of spirit inks, wood stains, and in antiseptic solutions used for neonatal nurseries.

Environmental Fate and Hazard. Malachite green ionic state makes this compound essentially non-volatile, therefore malachite green should exist solely in the particulate phase in the ambient atmosphere. Particulate-phase malachite green may be physically removed from the air, mainly by wet deposition. An estimated K_{oc} of 13 suggests that malachite green will have very high mobility in soil, although its ionic nature may result in ion-exchange processes with clay that would retard leaching. The volatilization of the dye from moist soil surfaces to air will not be important as malachite green is an ionic compound. Based on limited data, this compound is expected to be resistant to aerobic biodegradation in both soil and water; in an aqueous screening test, only 1.3% of the theoretical biological oxygen demand (BOD) was reached in 5 days. It may adsorb to clay sediments and particulate matter in the water due to ion-exchange processes. The loss of the dye from water by evaporation should not be important due to its ionic nature.

The potential for bioconcentration in aquatic organisms should be low based on an estimated BCF value of 2. A standard draize, human, skin, 2 mg/2-day/intermittent was found to be mild and was being investigated as a mutagen. *Saccharomyces cerevisiae* was used to study in an acute experiment the toxic and mutagenic effects of three different dyes that showed toxic effects as cell killing and growth inhibition (USNLM, 2003). An oral LDLo for a mouse and rabbit were 25 mg/kg and 75 mg/kg (Lewis, 1993).

Human Hazard. Occupational exposure may be through inhalation of dust particulates and dermal contact with this compound at workplaces, where malachite green is produced or used. The general population may be exposed to malachite green via dermal contact with products containing malachite green (USNLM, 2003). Malachite green has been employed topically on the skin as an antiseptic, when it was accidentally applied to the eye it caused severe injuries. In one instance an attempt to treat conjunctivitis with 1% solution of this dye resulted in destructive keratitis with hypopyon and terminated in

bilateral blindness due to corneal opacification. Ingestion causes diarrhea and abdominal pain.

Discussion. Malachite green will have very high mobility in soil, although its ionic nature may result in ion-exchange processes with clay that would retard leaching. Malachite green could have an impact on terrestrial or aquatic environments at and near DTRA test beds based on its high acute toxicity.

Test personnel exposed to malachite green will be at no risk if proper PPE is used. Malachite green is not expected to have any impact on the general human populations.

Pentafluoroethane (PFE; Halocarbon 125; Zyron 125) [CAS 354-33-6]

General Information. Pentafluoroethane is a colorless, non-flammable gas with a slight, ethereal odor. It is slightly soluble in water. It may be used as a replacement for chlorofluorocarbons (USNLM, 2003).

Environmental Fate and Hazards. This gas will be dissipated rapidly in well-ventilated areas. Pentafluoroethane's production and potential use as a replacement for chlorofluorocarbons (CFCs) may result in its release to the environment through various waste streams. If released to air, vapor pressure suggests pentafluoroethane will exist solely as a vapor in the atmosphere. In vapor-phase, it will be degraded very slowly in the atmosphere by reaction with photochemically produced hydroxyl radicals having an estimated half-life of 18 years. If released to soil, it will have moderate mobility and volatilization from moist soil surfaces, which is expected to be an important fate process. Pentafluoroethane may potentially volatilize from dry soil surfaces based upon its vapor pressure. If released into water, this compound's estimated Henry's Law constant indicates volatilization from water surfaces is expected to occur. It is estimated volatilization half-lives from a model river and model lake are 3.2 hours and 4.3 days, respectively. It is prone to have a low bioaccumulation rate in aquatic organisms. Highly fluorinated compounds such as pentafluoroethane are not expected to biodegrade rapidly. Estimated hydrolysis half-lives of 3.2 years and 120 days at pH values of 7 and 8, and hydrolysis is not expected to be an important process (USNLM, 2003).

Any adverse effect on animals would be related to adverse effects on the cardiovascular system and exposure to oxygen-deficient environments. The symptoms experienced by overexposed animals would be similar to those described for exposed humans. No adverse effect is anticipated to occur to plant-life, except for frost produced in the presence of rapidly expanding gases. No evidence is currently available on the effects on aquatic life.

Human Hazards. Occupational exposure to pentafluoroethane may occur through inhalation at workplaces where pentafluoroethane is produced. Pentafluoroethane can cause central nervous system depression after inhalation exposures. Symptoms of such overexposure can include drowsiness, fatigue, and weakness. At high concentrations, the gas can act as an asphyxiant, by displacing oxygen; therefore, exposure to high concentrations of this gas can be fatal. Frostbite can be caused by contact with rapidly expanding gases or the liquefied gas. This gas is not flammable or reactive in normal emergency response situations. Oxygen levels should be maintained above 19.5%. The American Industrial Hygienist Association and DuPont recommend a PEL of 1000 ppm, 8 hour TWA. It is not listed by NTP, OSHA, or NIOSH as a carcinogen (Chemical Safety Associates, Inc, 1998).

Discussion. Test personnel exposed to pentafluoroethane will be at no risk if proper protective equipment is used. Pentafluoroethane is not expected to have any impact on the general human population or terrestrial or aquatic environments at and near DTRA test beds.

Highly fluorinated compounds such as pentafluoroethane are not expected to biodegrade rapidly. Pentafluoroethane is not highly water soluble and unlikely to leach into groundwater. It has the potential to adsorb and bioaccumulate in the environment based on its solubility.

Scandium Oxide [CAS 12060-08-1]

General Information. Scandium oxide is a white, amorphous, odorless powder. It is soluble in hot acids and less so in cold acids. Its use is in the preparation of scandium fluoride and in the manufacture of high-intensity electric lamps (Lewis, 1993).

Environmental Fate and Hazards. Hazardous byproducts are not fully known other than irritating and toxic fumes and gases.

Human Hazards. Routes of exposure are through the eye, skin, ingestion and inhalation. Symptoms associated with exposure are irritation to the route of entry. The toxicological properties of this substance have not been fully investigated. The recommended exposure guideline for scandium oxide is 15 mg/m^3 (OSHA) and 10 mg/m^3 TLV (ACGIH). It is not listed by EPA, OSHA or NIOSH as a carcinogen (PIDC, 2002).

Discussion. The potential for scandium oxide to bioaccumulate is not known, nor are the effects of scandium oxide on plants and soil microbes known; therefore, it is not possible to assess the chronic ecotoxicity at DTRA test beds.

Test personnel exposed to scandium oxide will be at no risk if proper protective equipment is used. Scandium oxide is not expected to have any impact on the general population at and near DTRA test beds.

Sulfur hexafluoride (SF_6) [CAS 2551-62-4]

General Information. Sulfur hexafluoride is a fluorocarbon gas commonly used in industry particularly by electric utility companies. Research-grade SF_6 is pure, but industrial-grade SF_6 contains toxic disulfur fluoride impurities (Lewis, 1992b). Global annual emissions of SF_6 are estimated at 2500-5000 metric tons (Sematech, 1994). Because SF_6 is heavier than air and easily detected, it is used as a tracer gas in atmospheric studies. SF_6 is considered a greenhouse gas and the release of this gas is monitored by the EPA.

Environmental Fate and Hazards. SF_6 will exist in the vapor phase in the ambient atmosphere, based on an extrapolated sublimation vapor pressure of 9.0 x 10^{+4} mm Hg (25 °C). SF_6 is one of the heaviest known gases with a vapor density approximately five times that of air. Therefore, when released into the atmosphere, it will tend to remain close to the ground and be transported to earth by wet deposition. Long-term observations of SF_6 in the atmosphere have recently revealed that the concentration of sulfur hexafluoride has increased between 1970 and 1992. SF_6 has an atmospheric lifetime of 600 to 3200 years (USNLM, 2005; Sematech, 1994).

In soil, SF_6 will have high mobility based on an estimated K_{oc} value of 195. Volatilization from moist soil will occur rapidly based upon an experimental Henry's Law constant of 4.52 atm-cu m/mole. Volatilization from dry soil surfaces will be important given the vapor pressure of this compound. Biodegradation data for SF_6 is not available.

In water, SF_6 is expected to leach to sediment or particulate matter based on its K_{oc} value. This compound is expected to volatilize from water surfaces given its estimated Henry's Law constant. Estimated half-lives from a model river and model lake are 3.5 hours and 4.8 days, respectively. Bioconcentration in aquatic organisms should be low based upon an estimated BCF value of 11.

The acute intravenous LD_{50} for rats is 5790 mg/kg. SF_6 is generally not toxic to animals and plants, except under fire conditions. At temperatures at or above 400^{o}C, SF_6 decomposes into toxic thionyl fluoride compounds (BOC Gases, 1999b). The main products of SF_6 are decomposition in the presence of air are sulfur tetrafluoride, and sulfur tetrafluoromonoxide.

Human Hazards. Exposure to SF_6 may occur through the respiratory system or by dermal contact. SF_6 is generally not toxic to humans; however, SF_6 in liquid form may cause frostbite to exposed tissue due to rapidly volatilizing liquid and vapor. Because SF_6 gas is heavier than air, it may displace oxygen in non-ventilated areas, causing headache, dizziness, anesthesia, drowsiness, and other symptoms of oxygen deficiency. The PEL is 1000 ppm (6000 mg/m^3) TWA (NIOSH, 2003). SF_6 is not a carcinogen (NTP, 2005).

Discussion. Because SF_6 is generally nontoxic, it is not expected to affect the general population, or vegetation and animal communities at and near DTRA test beds. Personnel handling or tracking plumes, whether pure or adulterated SF_6 containing would be at little risk with the use of proper protective equipment. Release of SF_6 for plume tracking would contribute less than 0.002% to total global annual releases of this gas by industry and other users (proposed maximum annual release of 0.113 metric tons [250 lb.] by DTRA testing, compared to 2500-5000 metric tons released annually worldwide).

Simulated plume models were used to show dispersement of sulfur hexafluoride at the Intermediate Testbed (ITB) in DIPOLE JEWEL 5 within the PHETS and WSMR boundary (Figure 5-1). Movement of the plume across the test area is unlikely to affect civilian populations because the concentration of SF_6 is likely to be very low at that point.

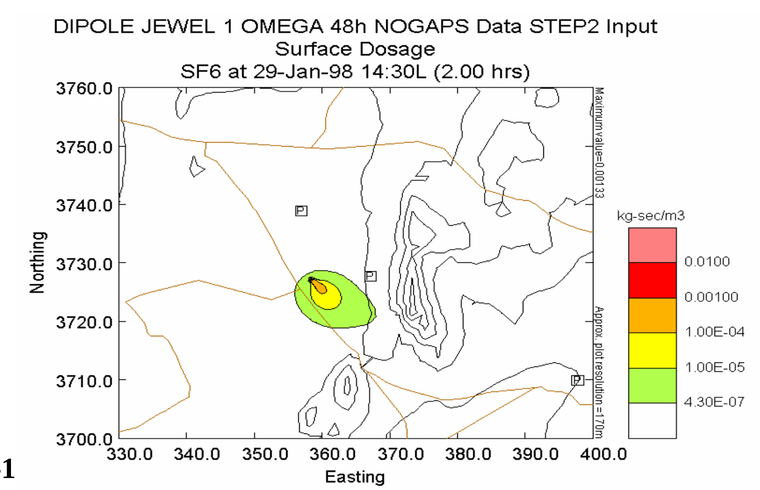

Figure 5-1 **98).**

Plume taggants

General information. Most plume taggants at DTRA test beds are exotic materials meant for one-time use only. They are released along with simulants and are used to visually track the plume. Rare earth oxides used as taggants are generally non-toxic and include alumina, dysprosium oxide, and indium oxide.

Environmental Fate and Human Hazards. None of the rare earth materials are hazardous to humans, plants, or animals and pose no risk to the environment (Molycorp,

1999). Because these taggants are powders, they may cause minor irritation to the eyes and respiratory tract when suspended in the air. The PEL for alumina is 5 mg/m^3; for dysprosium oxide is 3 mg/m^3; and for kaolin is 5 mg/m^3. There is no established PEL or TLV for indium oxide.

Discussion. With proper protective equipment, personnel involved in tests employing taggants are at no risk. Taggants are not expected to impact general population or the environment at and near DTRA test beds.

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6.0 INTERFERENTS

Interferents could be used during DTRA testing. Interferents simulate real time battlefield situations such as smoke screens or burning vehicles, this is achieved by burning various petroleum products (gasoline, tires, and oil). Flares and smoke grenades are other forms of interferents used. The possible use of these will slightly contribute to poor air quality. Emission byproducts can include carbon dioxide, carbon monoxide, sulfur oxides, nitrogen oxides, varies organic and inorganic compounds, and particulate matter. Non-essential personal should be evacuated from the area where these obscurants are to be used. Visibility will vary depending on the amount used and effects from these will not be significant enough due to their limited use and test dispersion throughout WSMR and the surrounding area.

Bleach [CAS 7681-52-9]

General Information. Bleach is often referred to as sodium hypochlorite. Pure sodium hypochlorite is a crystalline (sand-like) material with a chlorine odor. It is usually found in a clear to yellowish water solution used for disinfecting and deodorizing. Other uses of sodium hypochlorite in industry are in bleaching paper pulp, and textiles, intermediates, organic chemicals, water purification, medical purposes, and for fungicides (Lewis, 1993).

Environmental Fate and Hazards. It slowly decomposes in the presence of air. When exposed to sunlight decomposition is accelerated and it becomes less toxic over a time. Bleach emits toxic fumes of chlorine when heated to decomposition such as sodium oxide at high temperatures.

Acute oral LD_{50} for mouse was 5800 mg/kg. The LC_{50} for rainbow trout was 0.07 mg/L/48 hours and the LC_{50} for fathead minnow was 5.9 mg/L/96 hours (Fisher Scientific, 2001b). It is moderate (10 mg) irritant when applied to rabbit's eye and is being investigated as a tumorigen and mutagen (Mallinckrodt, 2003b).

Human Hazards. Primary routes of exposure are inhalation, ingestion, eye and skin contact. If inhaled, its vapor is considered to be poisonous and corrosive causing damage to the respiratory passages. An increase in concentration may cause irritation of the mouth, nose, and throat; however, prolonged exposure can cause coughing, runny nose, bronchopneumonia, headaches, breathing difficulty, pulmonary edema, and lung injury. If ingested, it can cause burns, abdominal cramps, nausea, vomiting, lowered blood pressure, diarrhea, shock and be poisonous, Shock, coma, and death may occur at

extremely high concentrations. It may cause irritation, burning, and may be corrosive to eye and surrounding tissue resulting in severe damage and blindness. The OELs are 0.5 ppm (TWA), 1 ppm short term exposure level (STEL)(as chlorine) (OSHA), and 1 ppm (TWA), 3 ppm (STEL) (as chlorine) (ACGIH) (Mallinckrodt, 2003b). There is inadequate evidence for the carcinogenicity of hypochlorite salts in experimental animals. No data were available from studies in humans on the carcinogenicity of hypochlorite salts (USNLM, 2003).

Burning Wood, Butyl Rubber, and Plastic

General Information. Wood, butyl rubber, and plastic burning are used as a form of interference to conceal vital targets from sight and interfere with observation instruments such as radar and satellites.

Environmental Fate and Human Hazards. The open burning of their waste produces particulate matter and hydrocarbons, which contain a number of toxic, irritant, and carcinogenic compounds. The smoke also contains carbon monoxide and carbon dioxide. The air pollutants produced by burning material can irritate the lungs, cause breathing problems, trigger asthma attacks, increase the chances of respiratory infection, and cause cancer. When wood, rubber, or plastic are burned, they produce smoke and release toxic gases. The smoke contains vapors and solid compounds suspended in the air called particulate matter. The particulate matter and toxic gases released during burning can be very irritating to people’s health.

People who are exposed to these air pollutants can experience eye and nose irritation, breathing difficulty, coughing, and headaches. People with heart disease, asthma, emphysema, or other respiratory diseases are especially sensitive to air pollutants. The chance of human health effects occurring depends mostly on the concentration of air pollutants in people’s breathing zone (the air that’s breathed around the nose and mouth).

Typically, no adverse health effects are expected, unless people are very close to the source of smoke or the smoke is not diluted enough with clean air.

The toxic chemicals released during burning include nitrogen oxides, sulfur dioxide, volatile organic chemicals (VOCs), and polycyclic organic matter (POM). Burning plastic and treated wood also releases heavy metals and toxic chemicals such as dioxin (Wood, 2003)

Discussion. By allowing controlled burns of these materials, the risk to test personnel will be minimized with the use of proper personnel protection equipment and by following safety procedures.

Kerosene [CAS 8008-20-6]

General Information. Kerosene is a mixture of hydrocarbons, chiefly C10-C16 alkanes. It appears as a pale-yellow to water-white, oily liquid (Lewis, 1993). It is insoluble in water and used as a fuel and solvent.

Environmental Fate and Hazards. Kerosene is expected to biodegrade under both aerobic and anaerobic conditions in the soil. Various components of kerosene may adsorb strongly to the soil, it may rapidly volatilize from both moist and dry soil. Kerosene is expected to biodegrade under both aerobic and anaerobic conditions in water. Some components of kerosene may significantly bioconcentrate in fish and aquatic organisms and strongly adsorb to sediment and suspended organic matter. The estimated half-life for volatilization of kerosene in a model river and lake are 3-6 hrs and > 130 days (the former model does not account for the attenuating effect of adsorption). In the air, kerosene may undergo oxidation by a gas-phase reaction with photochemically produced hydroxyl radicals with an estimated half-life of 2-3.4 days (USNLM, 2003).

The acute oral and dermal LD_{50} found in a rat and rabbit were greater than 5 g/kg and 2,000 mg/kg. The acute LC_{50} found in a rat was greater than 5000 ppm. It has been investigated as a tumorigen and mutagen (USNLM, 2003).

Human Hazards. Occupational exposure to kerosene may occur by inhalation or dermal contact during its production and use. Exposure to the general population may occur by inhalation or dermal contact while using products containing kerosene. Routes of exposure are inhalation, ingestion, adsorption through contact such as the skin or eye. Inhalation of kerosene can cause irritation to the respiratory tract with symptoms of coughing, shortness of breath, burning sensation in chest, headache, nausea, weakness, drowsiness, and coma. Ingestion of kerosene can cause irritation to the gastrointestinal tract and possible damage to the lungs. Skin and eye adsorption symptoms can include redness, itching, and pain. The PEL for kerosene is 100 mg/m^3 (NIOSH, 2003). It is not classified as a human carcinogen by NTP (U.S. Department of Health, 2002).

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7.0 OTHER TEST MATERIAL

Other test material can include a variety of additives to previously listed test materials. These materials have a range of occurring naturally to being manufactured and may have different effects to materials tested.

Bentonite Clay [CAS 1302-78-9]

General Information. Bentonite clay appearance is a tan powder with a mild odor. Its solubility is negligible in water (Clay Products, Inc., 1998). It is a colloidal clay composed of chiefly of montmorillonite. There are two varieties: sodium bentonite (found in Wyoming or Western US) that has a high swelling capacity in water, while calcium bentonite (found in Southern US) has a negligible swelling capacity (Lewis, 1993). Due to its sorptive and catalytic properties, bentonite is widely used in a variety of industrial applications. It is utilized as a pesticide carrier, an animal waste absorbent, a catalyst and catalyst support, and a decolorizing agent in oil refining, and in the pharmaceutical industries. It is also used as a decontaminate after military exercises. It is well known that bentonites in their natural state have limited sorbing capacity. This ability is greatly enhanced by treatment with strong acids. When bentonites are acid-activated by hot mineral acid solutions, hydrogen ions attack the aluminosilicate layers via the interlayer region. This process alters the structure, chemical composition, and physical properties of the clay while increasing its adsorption capacity. In refining vegetable oils, the bleaching process is an important step, used for removal of undesired components from the oil by adsorption (Foletto, 2003)

Environmental Fate and Hazards. Bentonite naturally occurs in the environment. Literature reviews found no mechanisms of degradation. Any bentonite entrained into the atmosphere by explosion or as aerosol would settle with other dust. The bentonite remaining at the target site or decontamination facility would be quickly cleaned up after the test and containerized for disposal (Robinson, 2004). Two studies done in freshwater and seawater concluded that the Rainbow trout (*Oncorhynchus mykiss*) and Spotted seatrout *(Cynoscion nebulosus)* LC_{50} were 19,000,000 (µg/L) over a 96 hour period and 7,500,000 µg/L over a 22 hour period (ECOTOX EPA).

Human Hazards. The toxicological properties of this material have not been fully investigated. It may cause eye and skin irritation and cause respiratory and digestive tract irritation. The PEL recommended by OSHA when working with bentonite is 0.1 mg/m^3 (Sigma-Aldrich, 2002c).

Bentonite clay mixes have been found to contain crystalline silica. The International Agency for Research on Cancer (IARC) has determined that over-exposure to crystalline silica can cause lung cancer and silicosis, a progressive lung disease in humans. Health affects from exposure to crystalline silica occur only when it is inhaled. Inhalation effects of crystalline silica has been shown to cause silicosis and lung cancer. Prolonged skin contact may lead to drying or cracking of the skin due to H_2O absorption properties of the clay. As with any dust, will be irritating to the eyes due to physical abrasion. Studies have shown that the crystalline silica is evenly distributed throughout all particle sizes of this product. Keep dust levels below permissible limits (Clay Products, Inc., 1998).

Discussion. Not a naturally occurring material in the proposed area.

Kaolin [CAS 1332-58-7]

General Information. Kaolin also known as "china clay." It is a soft fine, white, alumino-silicate mainly composed of kaolinite. It is formed through the alteration or "kaolinisation' of feldspar-rich parent rock by either weathering or hydrothermal processes. The final breakdown product is kaolinite. Kaolin has a wide range of uses including paper coating and filling and extender in plastics, rubber, paints, inks, food additives, cosmetics, insecticides, and filter aids, as an ingredient in pharmaceutical products.

Environmental Fate and Hazards. Kaolin related clays occur in several different types of deposits. Many kaolin deposits throughout the world are in the form of tabular lenses and discontinuous beds in sedimentary rock. Extensive sedimentary deposits of this type occur in the Georgia-South Carolina kaolin belt, Arkansas bauxite region and Ione district California (USNLM, 2003). From the available literature there will be no hazardous decomposition products formed (Mallinckrodt, 2004). It has been investigated as a reproductive effector. There is no hazardous decomposition product formed.

Human Hazards. Exposure to the skin or eye will not have an effect; however, it may cause some eye irritation. Ingestion of large doses of kaolin may produce gastrointestinal problems, while inhalation may cause irritation in the respiratory tract. Exposure to large doses may experience chronic pulmonary fibrosis and stomach granuloma (Mallinckrodt, 2004). The PELs are 15 mg/m^3 (TWA) (as total particulate) and 5 mg/m^3 (TWA) respirable fraction (OSHA) (Mallinckrodt, 2004). It is not listed as carcinogen by NTP or NIOSH (U.S. Department of Health, 2002).

Discussion. It is a nontoxic, nuisance dust and does not have a significant impact on human health or the environment.

Luria Broth (LB)

General Information. Luria broth is a light-beige solid with a characteristic odor. LB is primarily used as a biological cultural media.

Environmental Fate and Human Hazards. LB is found to be non toxic to humans. LB is an irritant, when ingested, inhaled, or when it comes into contact with the skin or eye. Acutmedia Manufacures of LB lists NaCl (table salt) as a hazardous component with a acute oral LD_{50} for rats at 3 g/kg. Hazardous decomposition products are carbon monoxide, carbon dioxide.

Discussion. Luria broth is not a human or environmental hazard, nor is it expected to interact with other chemical compounds to form a hazardous compound.

Magnesium Chloride [CAS 7786-30-3]

General Information. When found and manufactured, its appearance is a colorless or white crystal. It is water and alcohol soluble. Magnesium comprises approximately two percent of the earth's crust, eighth in elemental abundance, and widely distributed in the environment as a variety of compounds. Magnesium concentration is 1.8% and 1.6% in igneous and sedimentary rocks, respectively. In igneous rocks, magnesium is typically a constituent of the dark-colored ferro-magnesium minerals. While in metamorphic rocks, magnesium minerals such as chlorite, montmorillonite occur. Sedimentary rocks of magnesium include carbonates, hydroxides, and mixtures of magnesium and calcium carbonate. Rocks and minerals contain a higher percentage of magnesium than do soils as a result of the loss of magnesium due to weathering. Magnesium chloride, makes up 17% of sea salt and is released to the atmosphere as sea spray (USNLM, 2003). Its uses are found in magnesium metal, disinfectants, fire extinguishers, fireproofing wood, magnesium oxychloride cement, refrigerating, brines, ceramics, cooling drill tools, textile, paper manufacture, road dust laying compounds, and catalyst (Lewis, 1993).

Environmental Fate and Hazards. Animal toxicity studies showed that laboratory mice treated with magnesium chloride demonstrated that a diet containing over 2.5% $MgCl_2$ exerts toxic effects in mice. Another study suggested that magnesium increases the ventricular threshold of arrhythmias in normal, and denervated (heart-lung preparations) and also digitalis-treated hearts. The acute oral , intraperitoneal,and intravenous LD_{50} for a rat and mouse was 2800 mg/kg, 1338 mg/kg (mouse), and mouse 14 mg/kg (mouse) (USNLM, 2003). Hazardous decomposition products are hydrogen chloride, and chlorine.

Human Hazards. Human exposure studies by intraperitoneal and intravenous were found to either cause permanent injury or death, while also showing moderate effects such as reversible or irreversible changes to exposed tissue, only causing considerable discomfort (Lewis, 1993).

Magnesium chloride may cause skin and eye irritation and may be harmful if absorbed through the skin. When inhaled, it may be irritating to the mucous and upper respiratory tract. Exposure can cause central nervous depression, while also causing stomach pains, vomiting, and diarrhea. The chemical, physical, and toxicological properties have not been thoroughly investigated. The recommended OEL for magnesium chloride is 10 mg/m^3 TLV (as nuisance dust) (Peters Chemical Company, date not given). Magnesium chloride is not listed as a carcinogen by ACGIH, IARC, NIOSH, NTP, or OSHA (Fisher Scientific, 1997).

Oleoresin capsicum [CAS 404-86-4]

General Information. Oleoresin capsicum appearance is a reddish-orange liquid and pourable at room temperature. Its odor is pugent, spicy. It is fully dispersible in water.

Environmental Fate and Hazards. Capsaicin is a naturally occurring substance in plants of the Solanaceae family. In the draize test, capsaicin was neither an eye nor primary skin irritant in the rabbit, but was irritating to the dog's eye. Local capsaicin in the rat's eye caused low density of microvesicles and swollen mitochondria in nerve endings in the cornea, but no signs of axonal degeneration or alteration in fine structure of non-neural elements (USNLM, 2002).

Human Hazards. There is some concern that capsaicin may be potentially neurotoxic, however clinical studies with topical capsaicin have not shown this to occur. Capsaicin is thought to be capable of elevating the heat pain threshold in the treated skin areas, especially in patients with diabetic neuropathy; these patients often already have an elevated threshold for heat and pain. Contact with products containing capsaicin produces local irritation and lacrimation. The use of dried red chili peppers (Capsicum annuum cultivar) caused severe burning of the fingertips of a man who earlier had sustained abrasions of the fingers. The name "Hunan hand" was given to this syndrome, which is caused by the volatile oils activating dermal pain fibers (USNLM, 2002). It is not listed as a carcinogen by NTP or NIOSH (U.S Department of Health and Human Services, 2002). The PEL for oleoresin capsicum has not been established; however the recommended PEL for capsicum from the manufacture is 1000 ppm TWA (8-hr) (Dwire, 2001).

Phenol [CAS 108-95-2]

General Information. Phenol is a natural and man-made substance. It is found in nature in some foods, in human and animal wastes, and decomposing organic material. Phenol is a colorless-to-white solid when pure and found to be flammable. Commercial phenol is a liquid having a sickeningly sweet and tarry odor. Phenol evaporates more slowly than water; however, a moderate amount can form a solution with water (USNLM, 2003). It is also used in the manufacture of nylon and other synthetic fibers. It is also used in slimicides (chemicals that kill bacteria and fungi in slimes), as a disinfectant, as an antiseptic, and in medicinal preparations, such as mouthwash and sore throat lozenges. The largest single use of phenol is as an intermediate in the production of phenol resins. However, it is also used in the production of caprolactam (which is used in the manufacture of nylon 6 and other synthetic fibers) and bisphenol A (which is used in the manufacture of epoxy and other resins). Phenol ranks in the top 50 in production volumes for chemicals produced in the United States (ASTDR, 1998).

Environmental Fate and Hazards. Soil studies found that phenol is expected to have a high mobility in different soils. Phenol is not expected to volatilize from dry soil surfaces and degradation in soil is completed in 2-5 days, even in subsurface soils. Phenol is expected to absorb to suspended solids and sediment. Volatilization from water surfaces would not be expected to be a major fate process. Phenol was found to be completely mineralized in less than 1 day in water from 3 lakes; rates increased with increasing concentrations of phenol and the organic content of the water. Phenol was completely removed in river water after 2 days at 20^0C and after 4 days at 4^0C. Rates of photolysis were found to be 46, 43, and 39 hours in the summer, while in the winter they were found to be 173, 118, and 94 hours for distilled, poisoned estuarine, and estuarine waters. The photochemically reaction for phenol in the atmosphere is expected to have a half-life of 14.6 hours while at the nighttime, phenol reacts with nitrate radicals with a resulting half-life of 12 minutes.

A reported BCF in fish showed that there is rapid elimination of phenol in the environment suggesting that bioaccumulation of phenol is unlikely (USNLM, 2003). Phenol is expected to be toxic to aquatic life, while the LC_{50} (96-hour) for fish are between 10 and 100 mg/L. The acute oral LD_{50} in rats is 317 mg/kg and by inhalation it is 316 mg/m^3, while application to the rabbits skin is 630 mg/kg.

Human Hazards. Occupational exposure to phenol may occur through inhalation and dermal contact with phenol at workplaces where phenol is produced or used or via inhalation and dermal absorption of phenol-containing wastewater, emissions and

disinfectants or solvents. Monitoring data indicate that the general population may be exposed to phenol via inhalation of ambient air, ingestion of food and drinking water, and dermal contact with consumer or medicinal products containing phenol (USNLM, 2003). The seriousness of the effect of a harmful substance can be expected to increase as both the level and duration of exposure increase. It is also clear that phenol is produced by the body and excreted independent of external exposure to the compound. The normal range of phenol in the urine of unexposed individuals is 0.5–80 milligrams of phenol per liter of urine (mg/L). It is not known if phenol causes cancer in humans. Cancer has been shown to occur in mice when phenol was applied to the skin several times each week during the whole lifetime of the animal. When it is applied in combination with certain cancer-causing chemicals, a higher rate of cancer occurs than when the carcinogens are applied alone. Phenol did not cause cancer in mice or rats when they drank water-containing phenol for 2 years (ASTDR, 1998). The PEL is 5 ppm (19 mg/m^3) (NIOSH, 2003).

Phenol can have beneficial effects when used for medical reasons such as antiseptic (kills germs) when applied to the skin in small amounts and may have antiseptic properties when gargled as a mouthwash. It is an anesthetic (relieves pain) and is a component of certain sore-throat lozenges and throat sprays or gargles. Small amounts of phenol in water have been injected into nerve tissue to lessen pain associated with certain nerve disorders. Phenol destroys the outer layers of skin if allowed to remain in contact with skin, and small amounts of concentrated solutions of phenol are sometimes applied to the skin to remove warts and to treat other skin blemishes and disorders (ASTDR, 1998)

Discussion. Test personnel exposed to phenol will be at no risk if PPE is used. We can see by the plume model phenol concentration will be kept to a small area (Figure 7-1). Phenol is not expected to have any impact on the general population. Phenol is not expected to have any impact on terrestrial or aquatic environments at and near DTRA test beds.

Reported bio-concentration factors in fish showed that there is rapid elimination of phenol in the environment, suggesting that bioaccumulation of phenol are unlikely. Phenol is water soluble and has the potential to leach into groundwater. It is not expected that phenol will reach groundwater at DTRA test beds.

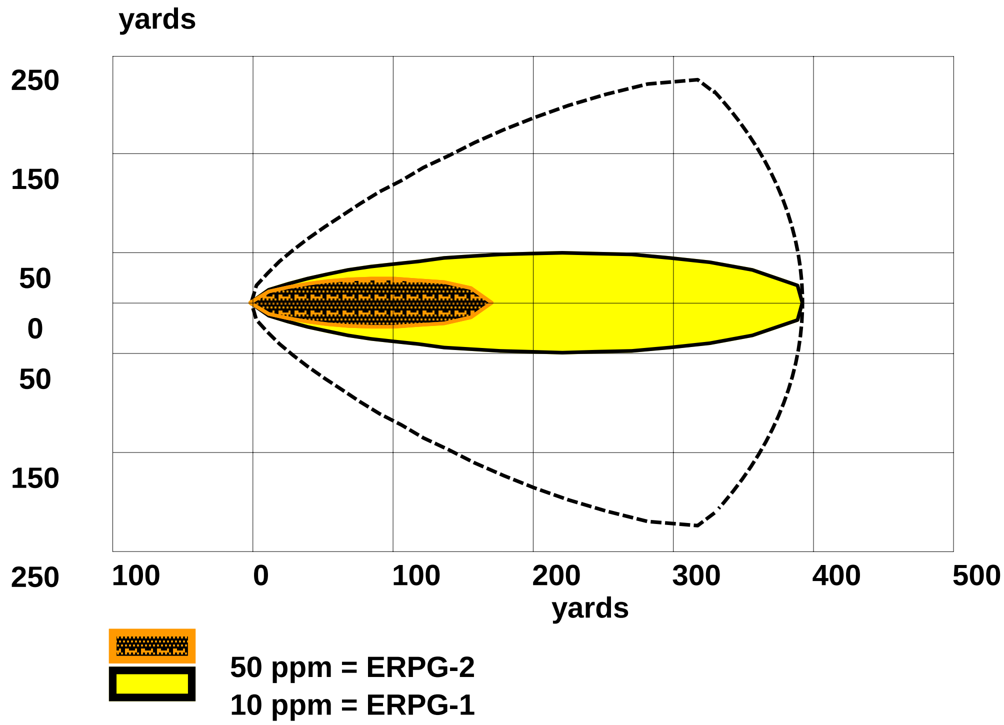

Figure 7-1. Predicted plume model for phenol (ALOHA, 2004).

Polymethyl Methacrylate (PMMA) [CAS 9011-14-7]

General Information. PMMA is a clear to opaque sheet in various colors and is odorless. PMMA is insoluble in water. The key ingredient found in PMMA is methyl methacrylate and is used to make Plexiglas, Altuglas, and Oroglas lines of PMMA sheet and resin products. It is used in automotive, construction, appliances, and other end-use markets. Methyl methacrylate is used not only for PMMA, but also for acrylic emulsions, plastics additives, and specialty products such as paints and coatings, packaging applications, vinyl siding, and other construction materials (Rohm and Haas, 2000).

Environmental Fate and Human Hazards. Acrylics are unaffected by aqueous solutions of most laboratory chemicals, by detergents, cleaners, dilute inorganic acids, and alkalies. Acrylics are easily sawed, drilled, milled, engraved, and finished with sharp carbide-tipped tools. Cut surfaces may be readily sanded and polished. They are also readily bend or thermoformed at low temperature and solvent bonding of properly fitting parts produces a strong, invisible joint. Acrylics are available in colorless clear as well as a wide variety of colors and tints. They are available in extruded and/or cast material in sheet, rod and tube forms as well as custom profiles.

Methyl methacrylate, a main ingredient of PMMA, when released into the air will exist solely as a vapor in the atmosphere. In vapor-phase, it will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 7.4 hours. Methyl methacrylate does not absorb light in the environmental UV spectrum (>290 nm), it is not expected to directly photolyze. If released to soil, methyl methacrylate is expected to have high mobility based upon a K_{oc} of 95. Volatilization from moist soil surfaces is expected to be an important fate process based upon an estimated Henry's Law constant of $3.2x10^{-4}$ atm-cu m/mole. Methyl methacrylate may potentially volatilize from dry soil surfaces based upon its vapor pressure. If released into water, methyl methacrylate is not expected to adsorb to suspended solids and sediment in the water column based upon the estimated K_{oc}. Volatilization from water surfaces is expected to be an important fate process based upon this compound's estimated Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 6 hours and 5 days, respectively (USNLM, 2002). Thermal decomposition or combustion may produce carbon doxide, carbon monoxide, and methyl methacrylate (Atofina, 2002). Hydrolysis of methyl methacrylate may be a significant process under basic conditions based upon a hydrolytic half-life of 3.4 hours at pH 11; half-lives at pH 7, 8, and 9 were 4 years, 140 days, and 14 days respectively.

An estimated BCF of 7 suggests the potential for bioconcentration in aquatic organisms is low.

Human Hazards. Occupational exposure to methyl methacrylate may occur through inhalation and dermal contact with this compound at workplaces where methyl methacrylate is produced or used. The general population may be exposed to methyl methacrylate via ingestion of drinking water and inhalation or dermal contact with resins, dental products, or artificial nail products containing methyl methacrylate.

This material is a polymer of methyl methacrylate monomers. The polymer is considered to be biologically inert and the only known potential hazards are those resulting from the mechanical irritancy of dusts which may arise from grinding and polishing operations. It has been reported to produce an asthmatic condition in an elderly individual after exposure to this material in dentures. This material produced no genetic changes in standard tests using human and bacterial cells and animals (Atofina, 2002). Hazardous decomposition products are methyl methacrylate, ethyl acrylate, carbon dioxide, and carbon monoxide depending on conditions of heating and burning. An OEL was not available or has not been established from the available literature. It is not listed by NTP, IARC, or OSHA as a carcinogen (Monomer-Polymer, 1993).

Polystyrene [CAS 9003-53-6]

General Information. Polymerized styrene is a thermoplastic synthetic resin of variable molecular weight depending on degree of polmerization. Polystyrene is a transparent, hard solid, and impact resistant. Polystyrene is an excellant electrical sulator. Polystyrene is not recommended for outdoor use, as modified polymer yellows when exposed to light, but light-stable modified grades are available. It is found as sheets, plates, rods, rigid form and expanable beads or spheres. It is used for packaging, machine holdings, clock and radio cabinets, and filler in shiper containers (Lewis, 1993).

Environmental Fate and Hazards. No bioconcentration is expected because of the high molecular weight (MW greater than 1000). It will accumulate in the soil and in the aquatic sediment It is expected to be inert in the environment. Surface photodegradation is expected with exposure to sunlight. No appreciable biodegradation is expected and it is not expected to be acutely toxic in the ecosystem.

Human Hazards. The PELs for polystrene are 15 mg/cM (total) OSHA (nuisance/inert dust) and 5 mg/cM (respirable) (OSHA, 2004). ACGIH has established a TLV (nuisance particulates) of 10 mg/cM (total), while OSHA's PEL is 100 ppm 8 hr. TWA (200 ppm ceiling), and as final at 50 ppm 8 hr. TWA (100 ppm STEL) and ACGIH TLV at 50 ppm 8 hr. TWA (100 ppm STEL). Polystrene is considered a human carcinogen by IARC.

Polystyrene-Butylmethacrylate (PSBA)

General Information. Polystyrene is a thermoplastic synthetic resin of variable molecular weight depending on its degree of polymerization. It is transparent and a hard solid. It is an excellent electrical and thermal insulator. It is used in packing, air conditioning cases, household containers and various other commercial goods (Lewis, 1993).

Butyl methacrylate's production and use in dental technology, oil dispersible pesticides, paraffin embedding media, contact lenses and for acrylic surface coatings may result in its release to the environment through various waste streams.

Environmental Fate and Hazards. In the air, butyl methacrylate's vapor pressure of 2.12 mm Hg (25 °C) indicates, it will exist solely as a vapor in the ambient atmosphere. In the vapor-phase, it will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals with a estimated halflife of 17 hours. Because the structurally similar ethyl methacrylate does not absorb light in the environmental UV spectrum (>290 nm), butyl methacrylate is not expected to directly photolyze. In soil, it will have low mobility based on an estimated K_{oc} of 880. Volatilization from moist soil surfaces is

expected to be an important fate process based on an estimated Henry's Law constant of $7.9x10^{-4}$ atm-cu m/mole. It may potentially volatilize from dry soil surfaces based upon its vapor pressure. Adsorption to soil may attenuate volatilization. Butyl methacrylate is expected to adsorb to suspended solids and sediment in the water column based on an estimated K_{oc} of 880. Volatilization from water surfaces is expected to be an important fate process based upon this compound's estimated Henry's Law constant. The estimated volatilization half-lives for a river and lake model are 5 hours and 5 days, respectively. However, volatilization from water surfaces is expected to be attenuated by adsorption to suspended solids and sediment in the water column. An estimated BCF of 91 suggests the potential for bioconcentration in aquatic organisms is moderate. Hydrolysis of butyl methacrylate may be a significant process under basic conditions based upon a hydrolytic half-life of 4 hours at pH 11 for the structurally similar butyl acrylate; half-lives for butyl acrylate at pH 7, 8, and 9 were 4 years, 150 days, and 15 days, respectively (USNLM, 2002).

Human Hazard. Occupational exposure to butyl methacrylate may occur through inhalation and dermal contact with this compound at workplaces where butyl methacrylate is produced or used. The general population may be exposed to butyl methacrylate via inhalation or dermal contact with acrylic surface coatings and dental products containing butyl methacrylate or exposure to contact lenses (USNLM, 2002). It may cause gastrointestinal irritation with nausea, vomiting and diarrhea. Mercaptans may cause nausea and headache. Exposure to high concentrations of mercaptans can produce unconsciousness with cyanosis (bluish discoloration of skin due to deficient oxygenation of the blood), cold extremities and rapid pulse. If inhaled, it may cause respiratory tract irritation. Vapors may cause dizziness or suffocation. It may produce nausea in low concentration and pulmonary edema in high concentrations. Exposure to high concentrations of mercaptans can produce unconsciousness with cyanosis (bluish discoloration of skin due to deficient oxygenation of the blood), cold extremities, and rapid pulse. The PELs for butyl methacrylate are 0.5 ppm (ACGIH), 500 ppm (IDLH) (NIOSH), and 10 ppm TWA (OSHA). It is not listed as a carcinogen by NIOSH, NTP, or OSHA.

Sand (silica) [CAS 14808-60-7]

General Information. It occurs widely in nature as sand, quartz, flint, and diatomite. It is a colorless crystal or white powder that is odorless and tasteless. It is insoluble in water and acids except hydrogen fluoride, but soluble in molten alkai when finely divided and amorphous. It can combine chemically with most metal oxides and melts to a glass with the lowest known coefficient of expansion. It is used in a varying degree of products such

as ceramics, abrasives, water filteration, cosmetics, thermal insulator, and ablative material in rocket engines (Lewis, 1993).

Environmental Fate and Human Hazards. At higher temperatures, silica can change crystal structure to form tridymite or cristobalite, which have greater health hazards. Silica is non-combustible. At the present time, it is being investigated as a tumorigen and mutagen.

Inhalation may increase the progression of tuberculosis; susceptibility is apparently not increased. Persons with impaired respiratory function may be more susceptible to the effects of this substance. Smoking can increase the risk of lung injury. Inhalation of quartz is classified as a human carcinogen. Chronic exposure can cause silicosis, a form of lung scarring that can cause shortness of breath, reduced lung function, and in severe cases, death.

Acute pneumoconiosis from overwhelming exposure to silica dust has occurred. Coughing and irritation of throat are early symptoms. If ingested, no adverse health effects have been noticed from occupational workers (USNLM, 2004). The PEL for sand as total dust is 30 mg/m^3 (OSHA) and by respirable fraction 10 mg/m^3. The PEL is 0.05 mg/m^3 (TWA) (as calciuim (Ca) respirable dust) (NIOSH, 2003). It is a suspected occupational human carcinogen by ACGIH (2005).

Discussion. The prevalent impact occurring will be added deposits of silica to the area where the testing is to occur.

Silicon [CAS 7440-21-3]

General Information. Silicon is a non-metallic element that is the second most abundant element on earth. It is a dark-colored crystal and soluble in a mixture of nitric and hydrofluoric acids and alkalies. It is insoluble in water, nitric acid, and hydrochloric acid. Silicon is the most important semi-conducting element used in computer circuitry, organosilicon compounds, silicon carbide, and as an alloying agent in steel (Lewis, 1993).

Environmental Fate and Hazards. Acute oral LD_{50} for rats was 3160 mg/kg, while the draize test was done on rabbit eyes and found to be a mild irritant at 3 mg. Silicon is not found free in nature, but occurs chiefly as the oxide, and as silicates. Sand, quartz, rock crystal, amethyst, agate, flint, jasper, and opal are some of the oxide forms. Granite, hornblende, asbestos, feldspar, clay, mica are a few of the numerous silicate minerals (USNLM, 2003).

Human Hazards. Silicon is a flammable solid and moisture sensitive so extra precaution is recommended by the manufacture. Silicon may cause central nervous system depression and may cause eye and skin irritation. It may cause respiratory and digestive tract irritation. Chronic inhalation of crystalline silica may lead to fibrotic lung disease, or cancer. Chronic inhalation of dust may lead to silicosis and cause silicosis-disabling pulmonary fibrosis characterized by fibrotic changes, dry cough, shortness of breath, emphysema, decreased chest expansion, and increased susceptibility to tuberculosis. The PEL is 10 mg/m^3 TWA (ACGIH), 10 mg/m^3 TWA (total dust) and 5 mg/m^3 TWA (respirable dust), and 15 mg/m^3 TWA (total dust) and 5 mg/m^3 TWA (respirable fraction). The IRAC has not listed silicon as a classifiable cancer source (Acros Organics, 2003).

Smokecloak FL 600 Fluid [CAS 107-21-1]

General Information. SmokeCloak is a colorless liquid with a mild odor. It is completely miscible in water. SmokeCloak's main component is monoproylene glycol which is also known as ethylene glycol. Ethylene glycol's production and uses such as a coolant and antifreeze, solvent, brake fluid, in cosmetics (up to 5%), ball point pen inks, printing inks, and adhesives. It is used as a component of deicing fluid for airport runways resulting in its direct release to the environment.

Environmental Fate and Hazards. Ethylene glycol will exist solely as a vapor in the ambient atmosphere. Vapor-phase ethylene glycol will be degraded in the atmosphere resulting in a half-life for this reaction in air is estimated to be 2 days. It is not expected to be susceptible to direct photolysis by sunlight, since it does not contain functional groups that are expected to absorb light with wavelengths > 290 nm. Ethylene glycol is expected to have high mobility in the soil based upon an estimated K_{oc} of 1. Volatilization from moist soil surfaces is not expected to be an important fate process based upon a Henry's Law constant of 6.0 x 10^{-8} atm mole/m^3. It is not expected to volatilize from dry soil surfaces based on its vapor pressure. In 2-12 days, ethylene glycol can be degraded in soil by 97-100 %.

In water, ethylene glycol is not expected to adsorb to suspended solids and sediment based upon the estimated K_{oc}. In a river die-away test, degradation was complete within 3 days (20 °C) and 5-14 days (8 °C) (USNLM, 2003).

A BCF of 10 suggests the potential for bioconcentration in aquatic organisms is low, after 3 days of exposure to ethylene glycol on the golden ide (*Leuciscus idus melanotus*) fish. Hydrolysis is not expected to be an important environmental fate process since this

compound lacks functional groups that hydrolyze under environmental conditions. Acute oral LD_{50} for a rat is 4700 mg/kg and the acute skin LD_{50} for a rabbit is 9530 mg/kg.

Human Hazards. Occupational exposure to ethylene glycol may occur through inhalation and dermal contact with this compound at workplaces where it is produced or used. Monitoring data indicate that the general population may be exposed to ethylene glycol via inhalation of ambient air and dermal contact with consumer products containing ethylene glycol. Skin and eye contact can cause minor irritation. The primary exposure to ethylene glycol for the general population is probably from contact with antifreeze, coolants, and latex paints containing ethylene glycol. Exposure to vapors over an extended time period has caused throat irritation and headache, nausea, vomiting, dizziness, and drowsiness. Pulmonary edema and central nervous system (CNS) depression may also develop. When heated or misted, it has produced rapid, involuntary eye movement and coma. Initial symptoms in massive dosage parallel alcohol intoxication, progressing to CNS depression, vomiting, headache, rapid respiratory and heart rate, lowered blood pressure, stupor, collapse, and unconsciousness with convulsions. Death from respiratory arrest or cardiovascular collapse may follow. Lethal dose in humans is 100 ml (3 - 4 ounces). The PEL is 50 ppm ceiling (OSHA PEL and ACGIH TLV). It is not listed as a carcinogen by NTP and IARC (Mallinckrodt, 2004).

Sticky Foam

General Information. Sticky foam appears as a light brown material with a slight pungent odor. It can collapse to a sticky, tenacious liquid and is insoluble in water. Its composition is derived from rubbers, resins, oils, fire retardants and foam stabilizing chemicals. It is used in fire suppression to riot-control in certain instances. Sticky foam is being tested at the Sandia National Laboratory (SNL) in Albuquerque, NM. Project engineers are working on a foam restraint system that will render a person immobile. The project foam is delivered from a specially-developed dispenser that is carried in a shoulder sling. When fired, it ejects the sticky foam from the dispenser's cylinder. The disadvantages can be lethal, when applied to the face such as suffocation. Another disadvantage, the solvents used to unstick the person(s) are potentially toxic and do not have a antidote. One alternative would be to cut the person out of the foam with a either a knife or scissors. Sticky foam itself is relativity non-toxic.

Environmental Fate and Hazards. Chlorodifluoromethane is a key ingredient in sticky foam. In the air, its vapor pressure indicates it will exist solely in the gas-phase in the atmosphere. In the gas-phase, it will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals having an estimated half-life of 9.4 yrs. As

a result of its long half-life, a substantial fraction of chlorodifluoromethane will slowly diffuse to the stratosphere. Once in the upper stratosphere, it is dissociated through photolysis, reaction with hydroxyl radical and excited atomic oxygen resulting in the release of chlorine. These chlorine atoms then become part of a catalytic process that contributes to the destruction of the ozone layer. In the troposphere, chlorodifluoromethane is not expected to undergo photolysis since it does not absorb light (> 290 nm). Since chlorodifluoromethane is a gas under ambient conditions, most of the chemical released on soils will volatilize rapidly. Any chlorodifluoromethane which remains on soil will have a potential for leaching based on an estimated K_{oc} of 35. If released into water**,** it is not expected to adsorb to suspended solids and sediment. Due to it's low biodegradability under both aerobic and anaerobic conditions, it is not expected to biodegrade in either soil or water. Its volatilization from water surfaces is anticipated to be important based upon this compound's Henry's Law constant.

An estimated BCF of 1 suggests the potential for bioconcentration in aquatic organisms is low. The chlorodifluoromethane hydrolysis rate is very low, <0.01 g/L-yr (30° C), and it is not expected to be an important degradation pathway in the environment. The acute oral LD_{50} for a rat was greater than 43200 ug/kg. The LC_{50} for a rat was 35 pph/15 minute(s) and for a mouse was 1380 mg/m^3/2-hours by inhalation (Sandia National Labortories, 1997).

Human Hazards. Occupational exposure to chlorodifluoromethane may occur through inhalation and dermal contact with this compound at workplaces where chlorodifluoromethane is produced or used. Monitoring data indicate that the general population may be exposed to chlorodifluoromethane via inhalation of ambient air and from leaky refrigeration units containing chlorodifluoromethane. Exposure to the skin may result in mild irritation and dermatitis. Sticky foam adheres readily to the skin and hair and is difficult to remove. Exposure to the eyes can result in moderate to severe damage, but when ingested it may result in asphyxiation. Symptoms associated with the exposure to chlorodifluoromethane vapor can cause confusion, pulmonary irritation, tremors and rarely coma. The OEL is 1000 ppm (3500 mg/m^3) (NIOSH, 2003). It is not considered a carcinogen by the EPA, ACGIH, or NTP (EPA, 2006; ACGIH, 2005; NTP, 2005).

Discussion. Working with chlorodifluoromethane, work personnel should be in a well-ventilated work area due to the danger of asphyxiation.

Tergitol 15-S-9 Nonionic [CAS 68131-40-8]

General Information. Tergitol 15-S-9 surfactant is a biodegradable, clear liquid that is ideally suited for applications requiring outstanding surface-chemical performance from a water soluble product. It is a mixture of linear secondary alcohols reacted with ethylene oxide. As a nonionic surfactant, it is chemically stable in the presence of dilute acids, bases, and salts, and is compatible with anionic, cationic, and other nonionic surfactants. Tergitol 15-S-9 is soluble in water, chlorinated solvents, and most polar organic solvents. It is one of the most versatile oil-soluble nonionic surfactants available and a proven performer in a myriad of industries, ranging from electronics to detergents. Specific end-uses for Tergitol 15-S-9 include oil field chemicals, water treatment operations, circuit board cleaners, and leather soaking, tanning, and dyeing operations to name a few.

Environmental Fate and Hazards. Acute oral LD_{50} for rats was 3360 µl/kg and the LD_{50} when applied to a rabbit skin was 4 ml/kg. In an irritation test, it was applied to a rabbit eyes at 5 mg resulting in severe irritation. Ecotoxicity to microorganisms was tested and it promoted bacterial inhibition at greater than 1000 mg/L/16 hours (LC_{50}). A LC_{50} value showed toxic effects in fathead minnows at 3.2 mg/L/96 hours. Hazardous decomposition products are carbon monoxide and carbon dioxide (Univar, 2001).

Human Hazards. Tergitol 15-S-9 can cause irritation in skin, eye, the digestive and respiratory systems. Symptoms associated with exposure will be nausea, headache, and vomiting. An OEL has not been established. It is not known if tergitol 15-S-9 is a carcinogen from the available literature.

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8.0 HIGH EXPLOSIVES

Military high explosives (HE) are safe to handle, have a long shelf life, their energy density is high and the propagation of the explosion is very fast. The energetic compounds are combined with polymers and other substances to match the properties as required. To initiate a detonation, a shock wave is needed. This is accomplished with a small quantity of a primary explosive. Modern, extremely insensitive formulations have been developed in most countries to eliminate accidents with ammunition. Apart from insensitive energetic compounds, new inert or energetic binder systems will be introduced to improve the vulnerability. The search for new energetic materials with highest performance characteristics is a never-ending task. Explosives that are commonly used in warheads include tritonal explosives and plastic bonded explosives (PBX). Tritonal explosives consist of 20 % aluminium/80 % trinitrotoluene (TNT). PBXN-109 is a PBX charge containing insensitive Royal Demolition eXplosive (RDX), which allows for transportation and handling with less chance of accidental detonation while retaining other characteristics of the composition. PBXIH-135 contains High Melting eXplosive (HMX), polyurethane rubber, and aluminum powder.

AFX-757 and AFX-777

General Information. AFX-757 and AFX-777 are constructed of high explosives and of various components. The explosive themselves could not be found, however one of components is aluminum. Aluminum’s individual environmental fate is found in section Energetic/Reactive Materials.

Ammonium Nitrate-Fuel Oil (ANFO)

Ammonium Nitrate (AN) [CAS 6484-52-2]

General Information. It is prepared commercially by reaction of nitric acid and ammonia. Its major uses are in fertilizers and explosives. It is found as small clay-coated pellets in fertilizer. It is also used in solid-fuel rocket propellants, pyrotechnics, and in the production of nitrous oxide. It is sometimes mixed with other substances, to build military explosives such as amatols, ammonals, manols, and amatexes as a partial replacement for TNT or RDX, so that they may be easily detonated. Yearly production in the United States was 15.66 billion lbs in 1992 to 16.79 billion lbs in 1993 and has steadily increased through the years (USNLM, 2003).

Environmental Fate and Hazards. Ammonium nitrate (AN) is a nutrient in water. Spills of AN may cause massive algal blooms in static waters and affect local species population balance in the aquatic environment. AN is quite soluble in water (250 g/100

ml at 20 °C). If precipitation occurs prior to clean up, or if water is used to disperse the spilled chemical, the solution of AN produced can infiltrate the soil and migrate downward toward the groundwater system. AN will be taken up by bacteria. Nitrate is more persistent in water than the ammonium ion; nitrate degradation is fastest in anaerobic conditions. When spilled on the soil, the liquid form will spread on the surface and penetrate into the soil at a rate dependent on the soil type and its water content. The immediate loss of fertilizer nitrogen as nitrous oxide (biochemical and microbiological) into the atmosphere was determined by in-situ measurements of the nitrous oxide evolution rates from uncultivated eolian sand. The net loss was equivalent to 0.1% of the applied fertilizer for ammonium chloride, 0.05% for AN and 0.01% for sodium nitrate. The total immediate loss of nitrous oxide-nitrogen after application of mineral fertilizer is estimated to be 0.004-1.2 teragram/yr.

Human Hazards. If inhaled, AN may cause irritation to the respiratory tract. Symptoms may include coughing, sore throat, and shortness of breath. At high temperatures, exposure to toxic nitrogen oxides decomposition products can quickly cause acute respiratory problems. Inhalation of large amounts causes systemic acidosis and abnormal hemoglobin. When large oral doses of nitrates are ingested they may cause dizziness, abdominal pain, vomiting, bloody diarrhea, weakness, convulsions, collapse and methemoglobinemia resulting in cyanosis (Mallinckrodt Baker, 2001a). No OEL have been established for AN nor is it known as carcinogen.

Fuel Oil No. 2 (FO) [CAS 68476-30-2]

General Information. Fuel oils are a variety of yellowish to light brown liquid mixtures that come from crude petroleum. Some chemicals found in fuel oils may evaporate easily, while others may easily dissolve in water. Fuel oils are produced by different petroleum refining processes, depending on their intended uses. Fuel oils may be used as fuel for engines, lamps, heaters, furnaces, and stoves, or as solvents. Some commonly found fuel oils include kerosene, diesel fuel, jet fuel, range oil, and home heating oil. These fuel oils differ from one another by their hydrocarbon compositions, boiling point ranges, chemical additives, and uses (Fuel Oil, 1995). Light fuel oils such as fuel oil No. 1 and No. 2 are manufactured from straight distillation of crude oil, or distillation of crude oil in the presence of a catalyst, and are chemically enhanced with antioxidants, dispersants, or corrosion inhibitors to meet the requirements for a specific application.

Environmental Fate and Hazards. When spilled, fuel oil will normally evaporate and hydrocarbon components may contribute to atmospheric smog. If released to the subsoils, petroleum middle distillate fuels will strongly adsorb to soils. Groundwater should be

considered as an exposure pathway. Liquid and vapor can migrate through the subsurface and preferential pathways (such as utility line backfill) to downgradient receptors. Middle distillates are potentially toxic to freshwater and saltwater ecosystems. Distillate fuels will normally float on water. In stagnant or slow-flowing waterways, a hydrocarbon layer can cover a large surface area. As a result, this oil layer can limit or eliminate natural atmospheric oxygen transport into the water. With time, if not removed, oxygen depletion in the waterway can cause a fish kill or create an anaerobic environment. Also, this coating action can also kill plankton, algae, and water fowl. The acute oral LD_{50} for a rat was 14500 mg/kg.

Human Hazards. Breathing some fuel oils for short periods may cause nausea, eye irritation, increased blood pressure, headache, light-headedness, loss of appetite, and poor coordination. Breathing diesel fuel vapors for long periods may cause kidney damage and lower the blood's ability to clot. Drinking small amounts of kerosene may cause vomiting, diarrhea, coughing, stomach swelling and cramps, drowsiness, restlessness, painful breathing, irritability, and unconsciousness. Drinking large amounts of kerosene may cause convulsions, coma, or death. Skin contact with kerosene for short periods may cause itchy, red, sore, or peeling skin. PELs for working with fuel oil No.2 are 5 mg/m^3 as mineral oil mist and 100 mg/m^3 (skin) (ACGIH, 2003; OSHA, 2001). Fuel oil is not classified as a carcinogen to humans (Fuel Oil, 1995).

APHAS-4

General Information. APHAS-4 are constructed of high explosives and various components. APHAS-4 explosives and other components could not be found from the available literature.

Cyclotrimethylenetrinitramine (RDX) [CAS 121-82-4]

General Information. RDX stands for Royal Demolition Explosive. It is also known as cyclonite or hexogen. The chemical name for RDX is 1,3,5-trinitro-1,3,5-triazine. It is a synthetic product and does not occur naturally in the environment. It is a white powder and found to be insoluble in water. RDX is used in a combination with other explosives and is 1.5 times more powerful than TNT (Lewis, 1993). RDX is utilized in other industries such as a pyrotechnic, in demolition blocks, as a heating fuel for food rations, and as an occasional rodenticide (USNLM, 2002)

Environmental Fate and Hazards. RDX may be released to the environment through a variety of waste streams and during explosive use. If released into the water, the dominant fate process in translucent waters should be direct photochemical degradation.

The half-life for this process is on the order of a few weeks. Aerobic biodegradation in aquatic environments should not occur, although anaerobic degradation under the proper conditions in lakes, ponds, and groundwater may be a significant fate process. Hydrolysis of RDX in inland waters should not occur, although this process is known to proceed slowly in seawater (112 days). The experimental half-lives were determined for sunlight photolysis of RDX in distilled water, river water, and pond water resulted in 13, 14, and 9 days, respectively (USNLM, 2002). If released in the soil, cyclonite should display moderate to high mobility. RDX will biodegrade under anaerobic conditions in soil with complete degradation reported in 24 days; it is expected to be resistant to biodegradation in soil under aerobic conditions. In the treatment of a wastewater containing RDX and TNT, only a small amount of the RDX was removed in an aerobic static biological reactor, followed by removal of greater than 85% of the RDX in a contact oxidation reactor. RDX was added to 3 different soil samples and incubated for 56 days under aerobic conditions and was not biodegraded. RDX was not degraded following a 90-day incubation with water from the Holston River. When released to the atmosphere, cyclonite will exist solely in the particulate phase in the atmosphere. It adsorbs to suspended matter and particulates in water. Particulate-phase cyclonite may be physically removed from the air by dry deposition. Direct photochemical degradation of cyclonite in the atmosphere may also be significant (USNLM, 2002).

The potential for bioconcentration in aquatic organisms is low. Bioconcentration in bluegill sunfish (*Lepomis macrochirus*), channel catfish (*Ictalurus punctatus*), and fathead minnow (*Pimephales promelas*) was measured for RDX at 0.014 and 1.0 mg/L. Bioconcentration factors in edible tissue at the lower concentration ranged from 4.0 (catfish) to 5.9 (fathead minnow) and were slightly higher in viscera (5 in catfish to 11 in fathead minnows). Elimination of all RDX from the fish tissues at the low dose exposure occurred after 14 days in the bluegill and catfish, but not totally in the minnow. At the higher dose, minnows and catfish eliminated 70 - 84% of the accumulated RDX, but no elimination occurred in the bluegill.

Human Hazards. NIOSH has statistically estimated that 488 workers are exposed to cyclonite in the US. The probable routes of exposure for cyclonite (RDX) are through dermal contact during the manufacture, formulation, and use of this compound in the production of munitions. Eexposure to the general public should be limited to areas where cyclonite is manufactured, converted into munitions, or released through the demilitarization of antiquated munitions. Probable routes of exposure for the general public can include ingestion of contaminated water, and inhalation of contaminated particulate matter produced during the incineration of cyclonite containing waste material

(USNLM, 2002). RDX can cause seizures in humans and animals when large amounts are inhaled or ingested. The effects of long-term (365 days or longer), low-level exposure on the nervous system are not known. Nausea and vomiting have also been seen, while no other significant health effects have been seen in humans. Rats and mice that ate RDX for 3 months or more had decreased body weights and slight liver and kidney damage. It is not known whether RDX causes birth defects in humans; it did not cause birth defects in rabbits, but it did result in smaller offspring in rats. It is not known whether RDX affects reproduction in people (ATSDR, 1995). The recommended OEL by NIOSH is 1.5 mg/m^3 and 0.5 mg/m^3 by ACGIH. RDX is a not a human carcinogen (USNLM, 2002).

Cyclotetramethylenetetranitramine (HMX) [CAS 2691-41-0]

General Information. HMX does not occur naturally in the environment and is a colorless solid. HMX is an acronym for High Melting eXplosive. It is also known as octogen and cyclotetramethylene-tetranitramine, as well as by other names. It is made from other chemicals known as hexamine, ammonium nitrate, nitric acid, and acetic acid. HMX explodes violently at high temperatures. Because of this property, HMX is used in various kinds of explosives, rocket fuels, and burster chargers. A small amount of HMX is also formed in making cyclotrimethylene-trinitramine (RDX), another explosive similar in structure to HMX. HMX is used to implode fissionable material in nuclear devices to achieve critical mass and as a component of plastic-bonded explosives (PBX), solid fuel rocket propellants, and as burster chargers in military munitions (EPA, 1988). The use of HMX as a propellant and in maximum-performance explosives is increasing (Army, 1989).

Environmental Fate and Hazards. HMX is likely to move from soil into groundwater, particularly in sandy soils. HMX may be released into the soil as a result of accidental spills, the settling of HMX-containing dust particles from the air, or the disposal of waste that contains HMX in landfills. A small amount of HMX will evaporate into the air and can be carried by the wind for some distances; however, in the air it can attach to suspended particles or dust from dust or ash from facilities that burn waste contaminated with HMX (ATSDR, 1997). HMX is found to slightly dissolve in water. Studies described the impact of photolysis and biotransformation on the persistence of HMX in water from the Holston River and LAAP lagoons. Photolysis was found to be the dominant transformation process in the Holston River, while poor light transmission through the lagoon waters inhibited photolytic processes. Conditions were not favorable for biotransformation in the Holston River or in LAAP lagoons. Computer simulations of the Holston River and the Louisiana Army Ammunition Plant (LAAP) lagoons indicated that HMX would be persistent in these environments with dilution serving as the major

factor in reducing HMX concentrations in these bodies of water. Photolysis was found to be the dominant transformation process with half-lives ranging from 17 days in Holston River; poor light transmission through the lagoon water inhibited photolytic processes to 7,900 days in lagoon water. Major photolytic transformation products found were nitrate, nitrite, and formaldehyde. In surface water, HMX does not evaporate or bind to sediments to any large extent. Sunlight breaks down most of the HMX in surface water into other compounds, usually in a matter of days to weeks (USNLM, 2003).

It is not known if plants, fish, or animals living in contaminated areas build up levels of HMX in their tissues. The acute oral LD_{50} for HMX was found to be 300 mg/kg for guinea pigs.

Human Hazards. Information on the adverse health effects of HMX is limited. In one human study, no adverse effects were reported in workers who breathed HMX. The concentrations of HMX in the workplace air were not reported in this study, and only a small number of workers and effects were investigated. Studies in rats, mice, and rabbits indicated that HMX may be harmful to the liver and central nervous system, if it is ingested or comes into contact with the skin. It is not known if HMX can affect the ability to have children, or if it can cause birth defects. It has not been classified to be a human carcinogen (USNLM, 2003). No OEL has been established.

Emulsion Explosives Iregel-82

General Information. Emulsion explosives consist of microdroplets of super-saturated oxidizer solution within an oil matrix. In most cases the oxidizer consists of ammonium nitrate. The oxidizer is dissolved in water which makes up about 9-12% of the emulsion. Emulsions are generally used in wet blastholes, where ANFO would be ineffective. Emulsion explosives have better water resistance than both watergel explosives and ANFO. Emulsion explosives are suitable for cold weather environments because their sensitivity does not decrease as significantly as watergel explosives. Emulsion explosives are relatively insensitive to detonation by friction, impact, or fire. Standard emulsion explosives are sensitized by air or gas bubbles. In some cases, the emulsion is made more sensitized by the addition of fuel grade aluminum powder. For underground mining, emulsion explosives are typically packaged in a thin, tough plastic film, giving it a good degree of rigidity and resistance to rupture during normal handling and tamping.

Emulsions can also be prepared as bulk explosives for large surface mining operations. As a bulk explosive they can be blended in varying ratios with ANFO to produce what is known as "Heavy ANFO". Varying the emulsion content will vary the shock/gas ratio

for improved vibration control, increased shock energy for fragmentation, or increased heave for cast blasting.

Environmental Fate and Hazards. Material as supplied and undamaged, presents no ecological problems provided any wastes are correctly disposed of. Emulsion explosives contain oil additives and water soluble nitrogenous salts which should not be allowed to contaminate water supplies such as rivers (AEL, 2002).

Spills of ammonium nitrate may cause massive algal blooms in static waters and affect local species population balance in the aquatic environment. Ammonium nitrate is quite soluble in water (250 g/100 mL at 20 °C). Thus, if precipitation occurs prior to clean up, or if water is used to disperse the spilled chemical, the solution of ammonium nitrate produced can infiltrate the soil and migrate downward toward the groundwater system. Ammonium nitrate will be taken up by bacteria. Nitrate is more persistent in water than the ammonium ion; nitrate degradation is fastest in anaerobic conditions. When spilled on soil, the liquid form will spread on the surface and penetrate into the soil at a rate dependent on the soil type and its water content.

Human Hazards. Routes of possible exposure are by ingestion, inhalation, eye and skin contact. It may cause irritation to allergic reaction in some persons and cause gastrointestinal disorder. At high concentrations nausea, vomiting, diarrhea, and collapse could occur, while nitrates cause dilation of blood vessels and methaemoglobin formation, which results in low blood pressure and low oxygen carrying capacity. No OEL has been established and it is not known to be a carcinogen.

GSI-005 & GSI-0018

General Information. GSI-005 and GSI-0018 are high temperature incendiaries made from boric acid and phosphoric acid and other components.

Boric Acid [CAS 10043-35-3]

General Information. Boric acid is a colorless, odorless scales or white powder and stable in water. It is soluble in boiling water, alcohol, and glycerol. It is used in heat-resistant (borosilcate) glass, glass fibers, porcelain enamels, boron chemicals, metallurgy, flame retardant in cellulosic insulation, mattress batting and cotton textiles products, fungus control on citrus fruits, ointment and eyewash, and nickel electroplating baths (Lewis, 1993).

Environmental Fate and Hazard. Boron is adsorbed by iron and aluminum hydroxy compounds and clay minerals. Finer textured soils retain added boron longer than do coarse, sandy soils. Boron sorption by clay minerals and iron and aluminum oxides are pH dependent, with maximum sorption in the range 7-9. The amount of boron adsorbed depends on the surface area of the clay or oxide and this sorption is only partially reversible. In seawater, boron is widely distributed in the environment concentrations near 4 µg/g, while in freshwater concentration is considerably less at 0.01 µg/g. Boron is widely distributed in the environment and concentrations average 3-10 µg/g in soil (USNLM, 2003). The acute oral LD_{50} for rat was 2660 mg/kg for boric acid.

Human Hazard. Acute exposure from boric acid through ingestion or absorption may cause nausea, vomiting, diarrhea, abdominal cramps, erythematous lesions on skin and mucous membranes, circulatory collapse, tachycardia, cyanosis, delirium, convulsions, and coma. It is irritating to the mucous membranes, and respiratory tract. Chronic exposure may cause dry skin, eruptions, weight loss, anemia, gastric disturbances, convulsions, kidney, liver or lung damage. Boric acid may cause reproductive effects.

Human lethal dose (LD) was 37 mg boron/kg as boric acid (ingestion) and 210 mg boron/kg as boric acid (dermal: infant) (USNLM, 2003).

Phosphoric Acid [CAS 7664-38-2]

General Information. Phosphoric acid is a natural constituent of many fruits and their juices. Phosphoric acid is the seventh largest volume produced chemical in the United States. Its appearance is a colorless, odorless, sparkling liquid or transparent, crystalline solid, depending on the concentration and temperature. At 20C^{o}, 50% and 75% concentration solutions are mobile liquids, the 85% is a syrupy consistency, and 100% is found in the crystal form. It is soluble in water and alcohol, but corrosive to ferrous metals and alloys. It is used in fertilizers, soaps and detergents, inorganic phosphates, rust-proofing, and other related uses (Lewis, 1993).

Environmental Fate and Hazard. When spilled onto soil, phosphoric acid will infiltrate downward, the rate being greater with lower concentration because of reduced viscosity. During transport through the soil, phosphoric acid will dissolve some of the soil material, in particular, carbonate-based materials. The acid will be neutralized to some degree with adsorption of the proton and phosphate ions also possible. However, significant amounts of acid will remain for transport down toward the groundwater table. Upon reaching the groundwater table, the acid will continue to move in the direction of groundwater flow. A contaminated plume will be produced with dilution and dispersion serving to reduce the

acid concentration. Acidity may be reduced readily by natural water hardness minerals, while phosphate may persist indefinitely (USNLM, 2003).

The acute oral LD_{50} for a rat was 1530 mg/kg, but when applied to a rabbits skin the LD_{50} was 2740 mg/kg.

Human Hazard. Probable routes of human exposure are inhalation of mist, ingestion, eye, and skin contact. Symptoms associated with phosphoric acid are conjunctivitis, burns, irritant to trachea, nausea and vomiting, stomachache, diarrhea, acid intoxication, and shock.

Phosphoric acid (orthophosphoric acid, metaphosphoric acid) topically may irritate and injure the eyes, owing to its acidity, but systemically phosphate has no poisonous action on the eye. Tested on human eyes, 0.16 M orthophosphoric acid buffered to pH 2.5 caused moderate brief stinging sensation, but no injury when applied as a single drop. A drop of the same solution adjusted to pH 3.4 caused no discomfort. The PEL is 1 mg/m^3 (3 mg/m^3) for both NIOSH and OSHA (NIOSH, 2003). The EPA, NIOSH, and OSHA do not consider phosphoric acid a carcinogen. Phosphoric acid mist is an irritant to the eyes, upper respiratory tract, and skin. The solid is especially irritating to the skin in the presence of moisture. A dilute solution buffered to pH 2.5 caused a moderate, brief stinging sensation but no injury when dropped in the human eye; however, a 75% solution will cause severe skin burns. Human toxicity values by inhalation were 100 mg/m^3 (TCLo). Persons at special risk with chronic pulmonary disease and skin disease could experience moderate to severe reactions. For persons with impaired pulmonary function, chronic pulmonary disease, especially those with obstructive airway diseases, the breathing of phosphoric acid dust or mist might cause exacerbation of symptoms due to its irritant properties. Persons with skin disease, phosphoric acid dust, mist, or solutions may cause dermatitis, and persons with pre-existing skin disorders may be more susceptible to the effects of this agent (USNLM, 2003).

HAS – 4 and HAS – 12

General Information. HAS–4 and HAS–12 are constructed of HMX and various components such as aluminum. HMX's environmental fate is found under High Explosives and alumnium's individual fate under Energetic/Reactive Materials.

MAC – 112

General Information. MAC - 112 are constructed of high explosives and various components. MAC - 112 explosive and other components could not be found from the available literature.

Nitromethane [CAS 75-52-5]

General Information. Nitromethane is a colorless liquid that is found to be soluble in water and alcohol (Lewis, 1993). Nitromethane is used as a chemical intermediate in the synthesis of many useful compounds, such as nitro and amino alcohols (alkanolamines), pesticides, chloropicrin (a soil fumigant), bronopol (a biocide), and ranitidine (an anti-ulcer drug). Nitromethane is a byproduct of RDX and HMX and its uses have included rocket fuel, a component of drag racing and hobby (model) car fuels. Its military uses include propellant and explosive applications, particularly in shaped charges, which are often used for targeted undersea explosions and line trenching. Other uses have included as a stabilizer for halogenated hydrocarbons, such as 1,1,1-trichloroethane, as a solvent for cyanoacrylate adhesives, acrylic coatings, cellulose compounds, polymers and waxes and for cleaning electronic circuit boards. Nitromethane occurs in car exhaust condensate and cigarette smoke (USNLM, 2003).

Environmental Fate and Hazards. Nitromethane may enter the environment in connection with its manufacture and use as a solvent, rocket fuel, and gasoline additive, as well as in vehicle exhaust and cigarette smoke. In addition, it is a byproduct in the manufacture of the explosives RDX and HMX. If released in soil, nitromethane would be expected to volatilize rapidly due to its high vapor pressure, and low adsorptivity to soil. It also may leach into the soil, where degradation should be low. When released in water, it will volatilize in 28.7 hr and 13 days in a model river and model pond. It should not absorb to sediment and particulate matter in the water column or bioconcentrate in fish. It may photodegrade in surface water, but no estimate of aqueous photodegradation rates was available. In the atmosphere, nitromethane will degrade due to photolysis in 4 - 9 hours. Reaction with photochemically produced hydroxyl radicals is very slow, occurring in 100 days (USNLM, 2003). Nitromethane absorbs UV radiation and undergoes primary dissociation to form free radicals, its half-life for photodissociation is 4.3 hours. Another study found the photodecomposition half-life for nitromethane in the presence of 5 ppm of nitric oxide to be 9.2 hours. Nitromethane was readily degradable in a solid surface photomineralization test with 4.4% mineralization to carbon dioxide in 17 hours.

Nitromethane does not bioconcentrate in fish. In a 3-day experiment performed with C^{14} labeled nitromethane, the bioconcentration factor in fish was 1.4. Therefore, the

accumulation of nitromethane in aquatic organisms is negligible. The bioconcentration factor in algae (*Chorella fusca*), as determined in a 24-hr experiment, was 960, indicating a slightly elevated bioaccumulation in algae (USNLM, 2003).

Human Hazards. The general population will be exposed to nitromethane by inhalation from motor vehicle exhaust and cigarette smoke. Humans are exposed to nitromethane in occupational settings via inhalation and dermal contact. The general population is exposed via inhalation primarily from auto exhaust and cigarette smoke. Workers may be exposed via inhalation and dermal contact associated with its use as a solvent or a component of rocket fuels. The PEL is 100 ppm TWA (250 mg/m^3) (OSHA) and 20 ppm TLV (ACGIH). It is listed as a carcinogen by EPA and OSHA (Mallinckrodt, 2003a).

PBXC – 133

General Information. PBXC – 133 is constructed of HMX explosive.

PBXIH – 135

General Information. PBXC – 135 is constructed of HMX explosive.

PBXIH – 136

General Information. PBXC – 133 is constructed of RDX explosive.

PBXN – 103

General Information. PBXC – 103 is constructed of RDX explosive.

PBXN – 109

General Information. PBXN – 109 are constructed of RDX and various components. RDX's environmental fate is found under High Explosives.

PBXN – 111

General Information. PBXN – 111 are constructed of RDX and various components. RDX's environmental fate is found under High Explosives.

PBXW – 128

General Information. PBXW – 111 are constructed of HMX and various components. HMX's environmental fate is found under High Explosives.

Pentaerythritol tetranitrate (PETN) [CAS 78-11-5]

General Information. Pentaerythritol (also called Tetramethylolmethane) is a polyalcohol compound containing 4 esterficable hydroxyl groups. It is a white crystalline odorless solid moderately soluble in cold water, freely soluble in hot water. It is used to make the explosive PETN and in the manufacture of alkyol resins and other coating compounds. It is produced from formaldehyde and acetaldehyde. There are commercially three grades of pentaerythritol: mono (98 percent, with di- and tripentaerythritol impurities), technical (88 percent, with 8 to 10 percent dipentaerythritol, balance tri-) and nitration (99 percent, with di- and tripentaerythritol impurities) (Pentaerythritol, 2000).

Pentaerythritol is used in the manufacture of alkyd resins, fatty acid rosin, and tall oil esters and to make paint and coatings, printing ink, coating adhesives, explosives, sealants, varnish, lacquer, vinyl chloride, synthetic rubber and miscellaneous including PETN, urethane coatings, flame retardant paints, polyvinyl chloride stabilizers, olefins, antioxidants and pentaerythritol triacrylate.

Environmental Fate and Hazards. PETN is found to be stable in sunlight and soluble in water, alcohol, and ether (Lewis, 1993). PETN is released to the environment as a munitions pollutant. If released to soil, PETN may absorb to soil. No data were located which suggest biodegradation is an important fate process of PETN in soil or water. If released to water, volatilization and bioconcentration in aquatic organisms are not expected to be environmentally important removal processes. Stepwise hydrolysis to pentaerythritol and nitrate ion may be a possible fate process of PETN in natural waters; however, no experimental data directly applicable to environmental conditions (pH 5-9) were located. If released to the atmosphere, vapor-phase PETN is expected to degrade by reaction with photochemically produced hydroxyl radicals (estimated half-life of 21 days).

Acute oral LD_{50} for rats was 100 g/kg and 19500 mg/kg. PETN is toxic by ingestion. In chronic animal studies by ingestion, PETN caused lung and gastrointestinal tract congestion, anxiety psychoses, central nervous system diseases, abnormal reflexes and death. It was not mutagenic in bacterial cell cultures.

Human Hazards. The general public may be exposed to pentaerythritol tetranitrate (PETN) by ingestion of capsules, tablets or sedatives during its use as a drug. Workers may be exposed by inhalation of dust or through eye and skin contact causing irritation.

PETN is a Division 1.1 explosive, and detonation may cause severe physical injury, including death. All explosives are dangerous and must be handled carefully and used

following approved safety procedures under the direction of competent, experienced persons in accordance with all applicable federal, state and local laws, regulations and ordinances.

Reported human health effects include convulsions, insomnia, restlessness and irritability. Seizures were followed by temporary amnesia, nausea and weakness. Immediately after convulsions, there was evidence of rapid pulse rate and hypertension. Recovery was eventually complete. PETN was not a human skin irritant and an epidemiology study did not identify any abnormalities attributed to PETN exposure.

Inhalation of explosive powders may cause nervous system irregularities including headaches and dizziness. Nitrogen oxides generated during use are skin, eye and respiratory tract irritants (Potter, 2002).

EPA, NIOSH, and OSHA have not listed PETN as a human carcinogen and its PEL is 1500 mg/m^3 TWA (skin) (OSHA).

Pentolite [CAS 8066-33-9]

General Information. Pentolite is a high explosive consisting of equal parts of pentaerythritol tetranitrate (PETN) and trinitrotoluene (TNT) (Lewis, 1993). Pentolite are high detonation pressure explosives and are sensitive to initiation when used with No. 6 caps and detonating cord. Upon initiation they detonate at a high velocity and very high detonation temperature. These qualities, together with high density produce great detonation pressure that makes them efficient primers and boosters. Pentolite Boosters contain no nitroglycerine and therefore are less sensitive to shock and friction than dynamite boosters and are found to store longer since they contain no liquid ingredients. They always detonate at their characteristic high velocity that develops maximum energy and are convenient to use and assemble (Pentolite, 2003).

Environmental Fate and Hazards. Refer to individual compounds for PETN and TNT.

Human Hazards. Refer to individual compounds for PETN and trinitrotoluene TNT.

Phosphorous (Red/White) [CAS 7723-14-0]

General Information. Phosphorus is commonly found in inorganic phosphate minerals and in all living cells, but it is never found alone in nature. It is highly reactive and emits a faint glow upon uniting with oxygen. It is an essential element for living organisms, and is insoluble in water (Phosphorous, 2000). White phosphorus uses are included in

rodenticides, smoke screens, and analytical chemistry. Red phosphorous uses include the manufacture of phosphoric acid and other phosphorous compounds, phosphorous bronzes, metallic phosphides, additives to semiconductors, safety matches, and fertilizers (Lewis, 1993).

Environmental Fate and Hazards. Phosphorus can enter air during production, use, or accidental spills during loading and unloading for shipment or transport. Elemental phosphorus may partition from water to sediment. Volatilization from water and soil transports small amounts of elemental phosphorus to air. Elemental phosphorus quickly oxidizes and hydrolyzes in air and in aerobic zones of water and soil to produce mainly oxides and acids of phosphorus, except when covered by a protective coating of phosphorus oxides. However, elemental phosphorus reaching the anaerobic zones of sediment and soil may persist for periods of l0 - 10,000 years. Therefore, anaerobic zones of soil and sediment may act as a sink for elemental phosphorus. In one study, the rate of volatilization decreased by increasing the depth to which the phosphorus was applied or by increasing soil moisture content; the rate did not go to zero (Sciences International, 1997).

Phosphorus reacts rapidly in air with an estimated half-life of about 5 minutes. The deployment of the military smoke/obscurant phosphorus in the field may produce an estimated 10% residual of unburnt phosphorus. Hydrolysis of elemental phosphorus in the atmosphere can produce phosphine. Phosphine in the presence of oxygen is highly reactive and is rapidly oxidized to phosphoric acid. The production of phosphine is inversely related to the oxygen concentration, and is thus favored by low oxygen pressures. Hence, the probability of phosphine formation in the atmosphere is low, because the concentration of oxygen is not conducive to it. Of the several products formed during the use of white phoshorus-felt obscurant/smoke, phosphine is especially important because of its toxicity. Therefore, the environmental fate of phosphine is briefly discussed. The important process for the loss of phosphine in the atmosphere is most likely its reaction with hydroxyl radicals. Based on measured rates under simulated conditions, the estimated lifetime of phosphine in the troposphere due to reaction with hydroxyl radicals is less than 1 day (Sciences International, 1997).

Elemental phosphorus can undergo oxidation and hydrolysis in water. The rate of reactions depends on the dissolved oxygen concentration, temperature, and state of phosphorus in water (dissolved, sorbed, colloidal, or particle form), and possibly the pH of the solution. The rate of reaction grows faster as the temperature of the water increases. At concentrations well below the solubility limit (3 mg/L), elemental

phosphorus disappeared from water by a first-order process with a half-life of 2 hours at about 10 °C and 0.85 hours at 30 °C (Sciences International, 1997).

Acute oral LD_{50} for duck was 6.55 mg/kg resulting in convulsions, seizures or muscle weakness. The lowest published lethal oral dose for duck was 3 mg/kg and for cat was 4 mg/kg. Acute oral LD_{50} for mouse was 4820 µg/kg and for rat was 3030 µg/kg. The associated effects seen prior to death in the duck were muscle weakness and convulsions, while in the rat and mouse a general somnolence was noticed prior to death (NIOSH, 2003)

Human Hazards. The typical intake of elemental phosphorus for the general population in the United States resulting from inhalation of air and ingestion of drinking water and food is not known. People who live near phosphorus production sites, user sites (e.g., Pine Bluff Arsenal), white phosphorous-felt artillery training sites, and dumpsites that contain elemental phosphorus may be exposed to elemental phosphorus at higher levels than the control population. People who live near accidental spill sites may also be exposed to phosphorus at high doses during a spill incident. There is a lack of data providing evidence of these high exposures. The PEL for phosphorus is 0.1 mg/m^3 TWA (OSHA, 2004).

Discussion. Persons living near the manufacture of phosphorus products will be at a higher risk of exposure; whereas, WSMR test personnel exposed to phosphorus will be at little risk, if proper PPE is used. Phosphorus is not expected to have any impact on the general population.

It is unlikely that phosphorus will leach into the groundwater due to its insolubility. Bioaccumulation potentially could be a problem in the soil and sediment, but unlikely due its chemical nature.

2, 4, 6-Trinitrotoluene (TNT) [CAS 118-96-7]

General Information. 2, 4, 6 - Trinitrotoluene is a yellow, odorless solid that does not occur naturally in the environment. It is commonly known as TNT and is an explosive used in military shells, bombs, and grenades, and in underwater blasting. Other uses of TNT were found as intermediates in dyestuff and photographic chemicals. Because alpha-TNT is not commercially produced in the United States and is only manufactured at military arsenals, production data are not readily available. However a single manufacturing plant may generate a half-million gallons per day of wastewater effluent (USNLM, 2003).

Environmental Fate and Hazards. 2, 4, 6-Trinitrotoluene (alpha-TNT) may be released to the environment in wastewater and air effluents from its production and use as a military explosive and propellant. Generally alpha-TNT is not expected to hydrolyze, volatilize from water, or bio-concentrate under normal environmental conditions. Alpha-TNT is expected to maintain low soil mobility and to a certain extent partition to sediments and particulate matter in the water column. Photolysis studies comparing river waters and distilled water have shown that the rate of alpha-TNT photolysis is directly related to increases in pH and organic matter content and increases overtime due to increased products of photolysis. Evidence also suggests that photochemical reactions of alpha-TNT may play a more important role in surface soils and environmental waters than does biotransformation. The vapor-phase reaction of alpha-TNT with photochemically produced hydroxyl radicals should be slow (half-life of 110 days). Concentration of alpha-TNT in waste water was reported between 100 and 140 ppm. Waste water from alpha-TNT manufacturing also contained other nitro-compounds including isomers of alpha-TNT and dinitrotoluenes. After the wastes are adjusted for pH and are exposed to sunlight, they undergo a chemical transformation resulting in the formation of highly colored waters. The way the water was disposed of in the past via holding ponds, rivers and streams and at times at sea. One study found that 8-10% of TNT in solution was lost to evaporation over an 18-day stripping experiment in which waste water from a TNT manufacturing process was aerated. Studies showed slow volatilization from environmental waters and the volatilization half-life from a model river was estimated at 119 days (USNLM, 2003).

Human Hazards. Workers involved in the production of explosives who were exposed to high concentrations of 2, 4, 6-trinitrotoluene in workplace air experienced several harmful health effects, through either inhalation and dermal contact This resulted in anemia and abnormal liver function, as well as spleen enlargement, and other harmful effects on the immune system, have been observed in animals that ate or breathed 2, 4, 6-trinitrotoluene. NIOSH (NOES Survey, 1981-1983) statistically estimated that 69 workers are potentially exposed to 2, 4, 6-trinitrotoluene in the USA. Other effects in humans include skin irritation after prolonged skin contact, and cataract development after long-term (365 days or longer) exposure. It is not known whether 2, 4, 6-trinitrotoluene can cause birth defects in humans. However, male animals treated with high doses of 2, 4, 6-trinitrotoluene have developed serious reproductive system effects. The EPA has determined that 2, 4, 6-trinitrotoluene is a possible human carcinogen. This assessment was based on a study in which rats that ate 2, 4, 6-trinitrotoluene for long periods developed tumors of the urinary bladder (USNLM, 2003). The PEL for TNT is 0.5 mg/m^3 (skin) (NIOSH) and 1.5 mg/m^3 (skin) (OSHA) (NIOSH, 2003).

Tritonal

General Information. Tritonal is a silvery solid that contains 80% TNT and 20% atomized aluminum powder. Tritonal is used as filler in bombs and shells. TNT and aluminum powder are insoluble in water.

Environmental Fate and Hazard. Hazardous decomposition products from combustion may yield carbon monoxide and/or carbon dioxide. 2, 4, 6-Trinitrotoluene (alpha-TNT) and aluminum may be released to the environment in wastewater and air effluents from its production and use as a military explosive and propellant. Alpha-TNT is not expected to hydrolyze, volatilize from water, or bio-concentrate under normal environmental conditions. Photolysis studies have shown that the rate of photolysis is related to the increase in pH and organic matter content. The vapor-phase reaction of alpha-TNT with photochemically produced hydroxyl radicals should be slow (half-life of 110 days). Studies showed slow volatilization from environmental waters and the volatilization half-life from a model river was estimated at 119 days (USNLM, 2003).

The acute toxicity of metallic aluminum and aluminum compounds is low. In short-term studies exposing rats, mice or dogs to various aluminum compounds in the diet or drinking-water, only minimal effects were observed at the highest administered doses. Adequate inhalation studies were not found. Following intratracheal administration of aluminum oxide, particle-associated fibrosis was observed. No overt fetotoxicity was noted, nor were general reproductive parameters noted after gavage treatment of rats. There is no indication that aluminum is carcinogenic. It can form complexes with DNA and cross-link chromosomal proteins and DNA, but it has not been shown to be mutagenic in bacteria or induce mutation or transformation in mammalian cells in vitro. Chromosomal aberrations have been observed in bone marrow cells of exposed mice and rats. There is considerable evidence that aluminum is neurotoxic in experimental animals, although there is considerable variation among species. In susceptible species, toxicity following parenteral administration is characterized by progressive neurological impairment, resulting in death with status epilepticus. Osteomalacia, as it presents in man, is observed consistently in larger species (e.g. dogs and pigs) exposed to aluminum; a similar condition is observed in rodents. Absorption via the gastrointestinal tract is usually less than one percent. Aluminum is distributed in most organs within the body with accumulation occurring mainly in bone at high dose levels. To a limited extent, aluminum passes the blood-brain barrier and is also distributed to the fetus. Aluminum is eliminated effectively by urine.

Human Hazard. Tritonal routes of exposure are mainly through ingestion and inhalation. If inhaled, mild irritation of the nose and upper respiratory system may develop. Symptoms of such overexposure may include sneezing, coughing, and nasal congestion. These symptoms are generally alleviated after overexposure ends. There is no established OEL for trintol.

Explosives Discussion

Current and proposed explosives include warhead explosives, bulk high explosives, and propellants commonly used on WSMR. Each is tested for its varying combustion and energy against enemy targets. The types of explosives used on WSMR are: tritonal, Ammonium Nitrate-Fuel Oil (ANFO), 2,4,6-Trinitoluene (TNT), Pentolite, Pentaeryythrritol tetrranitrate (PETN), Nitromethane, Emulsion Explosives, Cyclotrimethylenetrinitramine (RDX), and Cyclotetramethylenetetranitramine (HMX).

Explosives are primarily used in military applications, but other application include mining, intermediate chemicals, propellants, pyrotechnics, heating fuels, undersea drilling, and at times rodenticides. Each explosive has different environmental and health risks associated with it, therefore the use of proper protective equipment will minimize exposure and harm to test personnel.

Explosives and detonation may cause severe physical injury, including death. All explosives are dangerous and must be handled carefully and used following approved safety procedures under the direction of competent, experienced persons in accordance with all applicable federal, state and local laws, regulations and ordinances.

Most current and proposed explosives are not considered carcinogenic with the exception of 2, 4, 6-Trinitoluene (TNT). Male animals treated with high doses of 2, 4, 6-trinitrotoluene have developed serious reproductive system effects. The EPA has determined that 2, 4, 6-trinitrotoluene is a possible human carcinogen. This assessment was based on a study in which rats that ate 2, 4, 6-trinitrotoluene for long periods developed tumors of the urinary bladder (USNLM, 2003). Risks associated with explosives are eye, skin, respiratory, and digestive irritation. In some instantaneous, at high concentration, they may affect the central nervous system causing vomiting, abdominal pain, dizziness, and collapse. Ammonium nitrate is a naturally occurring chemical, while TNT, RDX, HMX are not and nitromethane is a byproduct from the manufacture of TNT. Ammonium nitrate and nitromethane are water-soluble, and will likely leach into the groundwater. They will volatize rapidly due to their high vapor pressure and not absorb to the soil. TNT, RDX, HMX, and fuel oil (FO) are insoluble in

water and will have a low tendency to leach into the groundwater. TNT, RDX, HMX, and FO will not volatize due to low vapor pressure and will not absorb to soil. Each explosive had a varying degree of degradation rate in soil, atmosphere, and water each being dependent on the temperature, vapor pressure, soil type, and pH.

Acute animal toxicity for most explosives appears to be low, given the LD_{50} values were low. No immediate direct effects on animal populations are expected at test sites due to the use of explosives. Different explosives are long lived in the environment and have a potential for buildup in the soil that could affect plant life.

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9.0 ENERGETIC AND REACTIVE MATERIALS

Advanced energetic testing is done to enhance the explosive power of weapons. Aluminum is the element most commonly added to explosive mixtures to create the desired effect. In the future, a wider variety of metals and alloys may be tested (e.g., magnesium, titanium, zirconium, iron, lithium, boron, nickel, copper, tungsten, and molybdenum). The search for new energetic materials with highest performance characteristics is a never-ending task.

Aluminum [CAS 7429-90-5]

General Information. Aluminum is a silvery-white, ductile and malleable metal. It is released to the environment both by natural processes and from anthropogenic sources. It is highly concentrated in soil-derived dusts from such activities as mining and agriculture, and in particulate matter from coal combustion. Aluminum occurs ubiquitously in the environment in the form of silicates, oxides, and hydroxides, combined with other elements such as sodium and fluorine and as complexes with organic matter. It is not found as a free metal because of its reactivity. Aluminum metal has a wide variety of uses, including structural materials in construction, automobiles and aircraft, and the production of metal alloys. Aluminum compounds and materials also have a wide variety of uses, including production of glass, ceramics, rubber, wood preservatives, pharmaceuticals and waterproofing textiles. Natural aluminum minerals, especially bentonite and zeolite, are used in water purification, sugar refining, brewing and paper industries.

Environmental Fate and Hazards. The acute toxicity of metallic aluminum and aluminum compounds is low. In short-term studies exposing rats, mice or dogs to various aluminum compounds in the diet or drinking water, only minimal effects were observed at the highest administered doses. Following intratracheal administration of aluminum oxide, particle-associated fibrosis was observed. No overt fetotoxicity was noted, nor were general reproductive parameters noted after gavage treatment of rats. Aluminum has shown not to be carcinogenic in animals. It can form complexes with DNA and cross-link chromosomal proteins, but it has not been shown to be mutagenic in bacteria or induce mutation or transformation in mammalian cells in vitro. Chromosomal aberrations have been observed in bone marrow cells of exposed mice and rats. There is considerable evidence that aluminum is neurotoxic in experimental animals, although there is considerable variation among species. In susceptible species, toxicity following parenteral administration is characterized by progressive neurological impairment, resulting in death with status epilepticus. Osteomalacia, as it presents in man, is observed consistently in larger species (e.g. dogs and pigs) exposed to aluminum; a similar

condition is observed in rodents. Absorption via the gastrointestinal tract is usually less than one percent. Aluminum is distributed in most organs within the body with accumulation occurring mainly in bone at high dose levels. To a limited extent, aluminum passes the blood-brain barrier and is also distributed to the fetus. Aluminum is eliminated effectively by urine.

Human Hazards. Routes of exposure of aluminum are by inhalation, digestion, dermal contact and by eye contact. Exposure can cause an irritation, with redness and pain. Not considered toxic although aluminum chloride may form slowly in the digestive tract and cause nausea, vomiting, and other gastrointestinal effects in extreme cases. It was found that children living in the vicinity of aluminum and steel factories had a decrease in tooth growth and it was found that chronic fluorosis generally develops after prolonged (10-20 years) exposure to industrial dusts, insecticides, or water where fluorides exceeded 3 to 4 ppm. This is especially true in workers involved in the production of aluminum, steel, or glass. A report from Italy indicated that aluminum production workers may also suffer from pneumoconiosis (Friberg, 1986).

Non-occupational human exposure to aluminum in the environment is primarily through ingestion of food and water. No acute pathogenic effects in the general population have been described after exposure to aluminum. It has been hypothesized that aluminum is a risk factor for Alzheimer's disease, present epidemiological evidence does not support a causal association between Alzheimer's disease and aluminum in drinking-water. Neurological syndromes including impairment of cognitive function, motor dysfunction and peripheral neuropathy have been reported in limited studies of workers exposed to aluminum fumes. Iatrogenic exposure in patients with chronic renal failure, exposed to aluminum-containing dialysis fluids and pharmaceutical products, may cause vitamin-D-resistant osteomalacia and microcytic anemia. Premature infants may develop increased tissue loading of aluminum, particularly in bone, when exposed to iatrogenic sources of aluminum. Human exposure to aluminum is widespread, in only a few cases has hypersensitivity been reported following exposure to some aluminum compounds after dermal application or intraperitoneal administration. There is insufficient information to allow for classification of the cancer risk from human exposures to aluminum and its compounds. Aluminum and its compounds appear to be poorly absorbed in humans. The mechanism of gastrointestinal absorption of aluminum has not yet been fully elucidated. The highest levels of aluminum may be found in the lungs, where it may be present as inhaled insoluble particles. The urine is the most important route of aluminum excretion. The PEL for aluminum is 10 mg/m^3 (total) and 5 mg/m^3 (resp.) (NIOSH, 2003).

Ammonium Nitrate (AN) [CAS 6484-52-2]

General Information. It is prepared commercially by reaction of nitric acid and ammonia. Its major uses are in fertilizers and explosives. It's found as small clay-coated pellets in fertilizer. It is also used in solid-fuel rocket propellants, pyrotechnics, and in the production of nitrous oxide. It is sometimes mixed with other substances, to build military explosives such as amatols, ammonals, manols, and amatexes as a partial replacement for alpha-2, 4, 6-trinitrotoluene (TNT) or cyclotrimethylenetrinitramine (RDX), so that they may be easily detonated. Yearly production in the United States was 15.66 billion lbs in 1992 to 16.79 billion lbs in 1993 and has steadily increased through the years (USNLM, 2003).

Environmental Fate and Hazards. Ammonium nitrate (AN) is a nutrient in water. Spills of AN may cause massive algal blooms in static waters and affect local species population balance in the aquatic environment. AN is soluble in water (250 g/100 ml at 20 °C). Thus, if precipitation occurs prior to clean up, or if water is used to disperse the spilled chemical, the solution of AN produced can infiltrate the soil and migrate downward toward the groundwater system. AN will be taken up by bacteria. Nitrate is more persistent in water than the ammonium ion; nitrate degradation is fastest in anaerobic conditions. When spilled on soil, the liquid form will spread on the surface and penetrate into the soil at a rate dependent on the soil type and its water content. The immediate loss of fertilizer nitrogen as nitrous oxide (biochemical and microbiological) into the atmosphere was determined by in situ measurements of the nitrous oxide evolution rates from uncultivated eolian sand. The net loss was equivalent to 0.1% of the applied fertilizer for ammonium chloride, 0.05% for AN and 0.01% for sodium nitrate. The total immediate loss of nitrous oxide-nitrogen after application of mineral fertilizer is estimated to be 0.004-1.2 teragram/yr.

Human Hazards. When inhaled, it may cause irritation to the respiratory tract; causing coughing, sore throat, and shortness of breath. At high temperatures, exposure to toxic nitrogen oxides decomposition products can quickly cause acute respiratory problems. Inhalation of large amounts causes systemic acidosis and abnormal hemoglobin. When large oral doses of nitrates are ingested they may cause dizziness, abdominal pain, vomiting, bloody diarrhea, weakness, convulsions, collapse and methemoglobinemia resulting in cyanosis (Mallinckrodt Baker, 2001). No OEL has been established for AN nor is it known as a carcinogen.

Ammonium Perchlorate [CAS 7790-98-9]

General Information. Ammonium perchlorate forms white crystals that are soluble in water. Its primary uses are found to be in explosives, pyrotectnics, analytical chemistry, etching and engraving agents, a smokeless rocket fuel, and jet propellant (Lewis, 1993).

Environmental Fate and Hazards. Perchlorate is considered to be one of the hazardous industrial pollutants that do not occur naturally. Perchlorate consists of an atom of chlorine surrounded by four atoms of oxygen. It occurs as ammonium, potassium, magnesium or sodium salts. These perchlorate salts bind weakly to soil particles and are not significantly broken down in the environment. In water, perchlorate salts are extremely soluble and highly mobile, migrating faster and farther than many other water contaminants. Together, these properties make perchlorate a particularly persistent and problematic pollutant once it contaminates groundwater (Gajjala, date not given). It has been found to persist for decades thereafter (NavNews, 2000). The acute LD_{50} by inhalation on a rat and rabbit was 4200 mg/kg and 1900 mg/kg (Kerr-MeGee Chemical Corp, 1992).

Human Hazards. Ammonium perchlorate is a mild irritant to the skin and eyes, mucous membranes and digestive tract. Chronic intake of perchlorate ion may have a reversible effect on the thyroid gland. Effects associated with overexposure are redness in the eyes or skin, mucous membranes, and hypo-thyroidism. The state standard drinking water in California is 18 mg/L (perchlorate ion) (USNLM, 2003). It is not considered a carcinogen by NTP or the USEPA (NTP, 2005; USEPA, 2006). The OEL has not been established for ammonium perchlorate.

Boron [CAS 7440-42-8]

General Information. Boron is a solid substance that occurs in nature. It is found not to occur alone, but is often found in the environment combined with other substances to form compounds such as borates. Common borate compounds include boric acid, salts of borates, and boron oxide. Boron and salts of borate have been found at hazardous waste sites. Borates are used mostly in the production of glass. They are also used in fire retardants, leather tanning and finishing industries, cosmetics, photographic materials, with certain metals, and for high-energy fuel. Pesticides for cockroach control and wood preservatives also contain borate (ATSDR, 1992).

Environmental Fate and Hazards. Boron alone does not dissolve in water nor does it evaporate easily, however it does stick to soil particles. Atmospheric boron may be in the form of particulate matter or aerosols as borides, boron oxides, borates, boranes,

organoboron compounds, trihalide boron compounds, or borazines. Borates are relatively soluble in water, and will probably be removed from the atmosphere by precipitation and dry deposition. The half-life of airborne particles is usually on the order of days, depending on the size of the particle and atmospheric conditions. Boron readily hydrolyzes in water to form the electrically neutral, weak monobasic acid H_3BO_3 and the monovalent ion B(OH). In concentrated solutions, boron may polymerize, leading to the formation of complex and diverse molecular arrangements. It was found that most environmentally relevant boron minerals are highly soluble in water and it is unlikely that mineral equilibrium will control the fate of boron in water. Water borne boron may be adsorbed by soils and sediments. Adsorption reactions are expected to be the only significant mechanism that will influence the fate of boron in water. The extent of boron adsorption depends on the pH of the water and the chemical composition of the soil. The greatest adsorption is generally observed at pH 7.5-9.0. The adsorption of boron may not be reversible in some soils. The lack of reversibility may be the result of solid-phase formation on mineral surfaces, and/or the slow release of boron by diffusion from the interior of clay minerals. Partition coefficients such as adsorption constants describe the tendency of a chemical to partition from water to solid phases. Adsorption constants for inorganic constituents such as boron cannot be predicted a priori, but must be measured for each soil-water combination. Boron adsorption will be most significant in soils that contain high concentrations of amorphous aluminum and iron oxides and hydroxides such as the reddish Ultisols in the southeastern United States. It is unlikely that boron is bioconcentrated significantly by organisms from water (ATSDR, 1992).

The BCFs of boron in marine and freshwater plants, fish, and invertebrates were estimated to be less than 100. Experimentally measured BCFs for fish have ranged from 52 to 198. These BCFs suggest that boron is not significantly bioconcentrated. Boron in water is completely absorbed by the human system, but it does not accumulate in body tissues. Acute oral LD_{50} found in rats and mice were 2660 mg/kg and 1740 mg/kg, respectively.

Human Hazard. There is little information on the health effects of long-term exposure to boron. Most of the studies are on short-term exposures. Breathing moderate levels of boron can result in irritation to the nose, throat, and eyes. Reproductive effects, such as low sperm count, were seen in men exposed to boron over the long-term. The lowest lethal dose (LDLo) found was given to a woman orally and was 200 mg/kg; and later it was investigated as a mutagen, tumorigen, and reproductive effector (Mallinckrodt Baker, 2003). Animal studies have shown effects on the lungs from breathing high levels of boron. Ingesting large amounts of boron over short periods of time can harm the

stomach, intestines, liver, kidney, and brain. Animal studies of ingestion of boron found effects on the testes in male animals. Birth defects were also seen in the offspring of female animals exposed during pregnancy (ATSDR, 1992). At the present there is little information on the effects of boron on skin, while animal studies have shown irritation (ATSDR, 1992). No OEL has been established for boron nor is it known as carcinogen (Carcinogenenic, 2002).

Hexachloroethane [CAS 67-72-1]

General Information. Hexachloroethane forms colorless crystals and has a campor-like odor. Hexachloroethane is soluble in alcohol and ether, but insoluble in water (Lewis, 1993). Hexachloroethane is an industrial chemical that is not known to occur naturally. It is not produced for commercial distribution in the United States, but is imported for use in military smoke and pyrotechnic devices, and as an intermediate in the organic chemicals industry. It is released to the environment from these uses, primarily to the atmosphere (ASTDR, 1997).

Environmental Fate and Hazards. Hexachloroethane is relatively unreactive and degrades slowly in environmental media. It volatilizes readily from water to the atmosphere, with a half-life of less than one day in some waters. In groundwater, the half-life of hexachloroethane may range from 365 days to less than a day when minerals and sulfide are present. Hexachloroethane may also leach through soil to groundwater. Hexachloroethane appears to remain in the atmosphere for long periods (half-life not available) and may migrate to groundwater, additional studies of adsorption and intermediate partitioning might be useful to assess the potential for emission and transport of this chemical from hazardous waste sites. Neither hydrolysis nor photolysis is expected to be important removal processes, but hexachloroethane may be reduced in aquatic systems in the presence of specific agents. Hexachloroethane exists in the air almost entirely as a vapor and there are no known processes that would impair its bioavailability from this medium. Since there is some adsorption of hexachloroethane to suspended solids and sediments in water, bioavailability from water may be limited. On the other hand, hexachloroethane is not expected to adsorb to soil significantly. Additional studies would be useful to determine the extent of bioavailability of hexachloroethane from contaminated air and drinking water near hazardous waste sites (Howard, 1997).

Hexachloroethane in water may bioconcentrate in aquatic organisms to a moderate degree, with a BCF of 139 reported in bluegills. Due to its rapid metabolism and the low incidence of hexachloroethane in ambient waters, food chain bioaccumulation is unlikely.

Acute oral LD_{50} for the rat was 4460 mg/kg and the LD_{50} for the rabbit when applied to the skin was 32 gm/kg. Bioconcentration in fish has been reported, but biomagnifications through the food chain is unlikely.

Biodegradation may contribute to hexachloroethane removal from ambient waters, but there is conflicting evidence regarding the significance of this fate process for hexachloroethane. Hexachloroethane has been detected at low (ng/m^3) levels in the atmosphere and occasionally in drinking water systems. It is rarely detected in surface waters or biota, and has not been reported in ambient soil, sediments, or commercial food products. Hexachloroethane has been identified in at least 45 of the 1,416 hazardous waste sites that have been proposed for inclusion on the EPA National Priorities List (ATSDR, 1997).

Human Hazards. Primary routes of exposure are through the eye and skin absroption, inhalation, or ingestion. Some segments of the population may be exposed by ingestion of contaminated drinking water (Howard, 1997). Symptoms associated with exposure are eye, skin and mucous membrane irritation. If ingested, it may cause central nervous system depression, kidney damage, and liver damage. Other symptoms may include may cause gastrointestinal irritation with nausea, vomiting and diarrhea. OSHA and the NIOSH have listed it as a possible cancer hazard based on tests with laboratory animals. The established PEL is 1 ppm TWA (10 mg/m^3) (OSHA) and 1 ppm TWA (skin - potential for cutaneous absorption, ACGIH).

Discussion. Additional information regarding hexachloroethane in soil or sediments was not available. Since this chemical is not prevalent in the environment, monitoring of ambient environmental media does not appear to be required at this time. However, monitoring of workplace air and environmental media at hazardous waste sites and military training areas at which hexachloroethane has been detected would help to determine potential sources of exposure. Reliable monitoring data for the levels of hexachloroethane in contaminated media at hazardous waste sites are needed so that the information obtained on levels of hexachloroethane in the environment can be used in combination with the known body burden of hexachloroethane to assess the potential risk of adverse health effects in populations living in the vicinity of hazardous waste sites.

Isopropyl nitrate (IPN) [CAS 1712-64-7]

General Information. Isopropyl nitrate is a colorless liquid. Because of its oxidizing property, it is used as a fuel additive and as a high-energy accelerant.

Environmental Fate and Hazard. Lethal concentration by inhalation for mice was 65 $gm/m^3/2$ hour and for rats 29 $gm/m^3/2$ hour. Hazardous decomposition products are carbon monoxide, oxides of nitrogen, irritating and toxic fumes and gases, carbon dioxide.

Human Hazard. Routes of exposure are ingestion, inhalation, skin absorption and eye contact. Symptoms associated are irritation and burning to skin, eye, or respiratory tract. It may at times cause permanent corneal opacification, chemical conjunctivitis, and corneal damage. If ingested, it may cause gastrointestinal irritation with nausea, vomiting, and diarrhea possibly with blood. Ingestion may cause burns to the gastrointestinal tract, while large amounts may cause CNS depression. If inhaled, vapors may cause burning sensation in the chest and cause dizziness or suffocation. It may cause acute pulmonary edema, asphyxia, chemical pneumonitis, and upper airway obstruction caused by edema. It may cause methemoglobinemia (bluish skin due to deficient oxygenation of blood), rapid heart rate, unconsciousness, and possible death. It is not considered a carcinogen by OSHA, NTP, NIOSH, or ACGIH. No OEL has not been established (Acros Organics, 2003).

Magnesium [CAS 7439-95-4]

General Information. Magnesium is the eighth most abundant element in the earth's crust. It a silvery, moderately hard alkaline-earth metal.It is not found free in nature, it is available in minerals including magnesite and dolomite. The metal may be obtained by electrolysis of fused magnesium chloride derived from brines and seawater. Magnesium is used in pyrotechnic and incendiary devices. It is alloyed with other metals to make them lighter and more easily welded, with applications in the aerospace industry. Magnesium is added to many propellants. It is used as a reducing agent in the preparation of uranium and other metals that are purified from their salts. Magnesium hydroxide (milk of magnesia), sulfate (Epsom salts), chloride, and citrate are used in medicine. Organic magnesium compounds have many uses. Magnesium is essential for plant and animal nutrition. Chlorophyll is a magnesium-centered porphyrin (Lewi, 1993).

Environmental Fate and Hazards. Toxicity in bakers yeast (*Saccharomyces cerevisiae*) was investigated and found to inhibit its growth at concentrations of 0.5 mM Mn^{2+} or higher (Blackwell, 1998). Although from the available data, magnesium exposure appeared to cause no considerable damage in laboratory animals. In one experiment, guinea pigs were treated with magnesium and no evidence of residual fibrosis appeared six weeks after treatment had stopped (USNLM, 2003).

Human Hazard. Routes of exposure are by inhalation, ingestion, dermal contact, and eye contact. Inhalation of dusts or fumes may irritate the respiratory tract and may cause metal fume fever. Other symptoms may include coughing, chest pain, fever, and leukocytosis. Ingestion of magnesium metal does not have well-characterized toxicity and may cause abdominal pain and diarrhea. Dermal contact by particles embedded in the skin may cause eruptions and molten magnesium may cause serious skin burns. Eye contact may cause mechanical irritation. An OEL has not been established and it is not a carcinogen (USNLM, 2003).

Potassium Perchlorate [CAS 7778-74-4]

General Information. Potassium perchlorate is colorless crystal or white, crystalline powder. It is soluble in water and insoluble in alcohol. Uses vary from explosives, oxidizing agents, photograph developing, pyrotechnics and flares, reagent, and oxidizer in solid rocket propellants (Lewis, 1993).

Environmental Fate and Hazards. Decomposition chemicals that can be released are chlorine and oxides of potassium. Potassium perchlorate is known to be a teratogen resulting in abnormalities in the endocrine system. Oral exposure to rats and rabbits was 27675 mg/kg and 2100 mg/kg resulting in abnormalities in the endocrine system (Sigma-Aldrich, 2002). A LC_{50} of 3550/4000 mg/L was toxic to the golden orfe (*Leuciscos idus*) (Sigma-Aldrich, 2002f).

Human Hazards. Routes of exposure are through inhalation, skin absorption, digestion, and eye contact. The effects are severe irritation to eyes, skin, and respiratory tract. Target organs are kidneys, thyroid, and blood. Potassium perchlorate has produced fatal aplastic anemia along with other blood disorders which include agranulocytosis, thrombocytopenia, and leucopenia. It reduces the ability of the thyroid to uptake iodide and stimulates the release of inorganic iodide that has been taken up previously. Absorption into the body leads to the formation of methemoglobin which in sufficient concentration causes cyanosis. Onset may be delayed 2 to 4 hours or longer. An OEL has not been established (Sigma-Aldrich Aldrich, 2002f). It is not listed as a carcinogen by NTP, ACGIH, or NIOSH (Acros Organics, 2002).

Sodium Perchlorate [CAS 7601-89-0]

General Information. Sodium perchlorate is a white, deliquescent crystal that is very hygroscopic. It is soluble in water, alcohol, and found to be a strong oxidizer. It is used in explosives, jet fuel, and as an analytical reagent (Lewis, 1993).

Environmental Fate and Hazards. Decomposition chemicals that can be released are hydrogen chloride, chlorine, and oxides of chlorine. Acute oral LD_{50} found in rats was 2100 mg/kg (Acros Organics, 2003).

Human Hazards. Routes of exposure are through inhalation, ingestion, dermal contact, and eye contact. It may cause eye irritation and possible damage, and may cause skin irritation. If ingested, it may cause methemoglobinemia, cyanosis (bluish discoloration of skin due to deficient oxygenation of the blood), convulsions, and death. When inhaled it may cause respiratory tract irritation. Prolonged or repeated exposure may cause thyroid inhibition. Sodium perchlorate is not listed as a carcinogen by ACGIH, NTP, or OSHA and no OEL has been established (Acros Organics, 2003e).

Teflon Polymer (Viton, Teflon, PTFE) [9002-84-0]

General Information. Teflon is not a naturally occurring compound. It is also referred to as polytetrafluoroethylene (PTFE). PTFE is a highly crystalline polymer which is very resistant to attack by corrosives and solvents. PTFE is insoluble in water. It also has extremely good thermal resistance at temperatures up to 250 °C. PTFE is used in a broad range of applications, including gasketing, pump parts, bearings, and anti-stick applications (Lewis, 1993).

Environmental Fate and Hazards. Hazardous decomposition products are carbon monoxide, carbon dioxide, and hydrogen fluoride. Abnormal embryonic development was seen when Teflon was implanted in the rat and mouse at a lowest published toxic dose (TDLo) of 80 mg/kg and 1140 mg/kg, respectively.

Human Hazards. Routes of exposure are the eye, skin, ingestion, and inhalation causing irritation. Vapors may cause conjunctiva irritation. If inhaled, aspiration may lead to pulmonary edema. Exposure to thermodegradation products may cause influenza-like symptoms such as chills, headache, mild respiratory discomfort, shaking of the limbs, and high fever. It is not listed as a carcinogen by OSHA, EPA, or NIOSH. No OEL was available from the available literature (Acros Organic, 2000).

Titanium [CAS 7440-32-6]

General Information. Titanium is the ninth most abundant element in the earth's crust. It is widely distributed in the form of stable minerals and occurs at an average concentration of 4400 mg/kg. It is usually found in the form of stable minerals (e.g., the end products of the weathering of basic rocks) principally ilmenite and rutile, and in the form of impurities or dispersions in many aluminosilicates. Owing to its great affinity for oxygen

and other elements, titanium does not exist in the metallic state in nature. A variable amount of titanium occurs in unweathered particles of clay, in amphibole, laepidomelane, and micas. The most common titanium minerals are ilmenite ($TiFeO_3$), which can contain a maximum concentration of dioxide (TiO_2) of 530 g/kg, and rutile, which is 100% titanium dioxide. Titanium-bearing minerals such as anatase and brookite are associated with ilmenite and rutile. Both rock and sand deposits contain titanium minerals. Rutile, ilmenite, brookite, and other common titanium minerals accumulate in sedimentary rocks and sometimes in certain soils as the end products of metamorphism of titanium-containing minerals and rocks. It is present in the form of titanium (IV) compounds; the rarer oxidation form of titanium (III) is also known in certain iron minerals as complex titanium (IV) compounds. Titanium levels in coal and oil have been reported to average 500 and 0.1 mg/kg, respectively. When refined, it is a silvery solid or dark gray amorphous powder and found to be insoluble in water (Lewis, 1993). The principal oxidation state of titanium is IV. The production and use of titanium compounds in alloys, pigments (e.g. titanium dioxide), catalysts, and structural metals may result in its release to the environment through various waste streams (USNLM, 2003).

Environmental Fate and Hazards. Incineration of titanium-containing products may release titanium into the atmosphere. If released to air, titanium compounds are expected to exist solely in the particulate phase in the ambient atmosphere. Particulate-phase titanium compounds may be removed from the air by wet and dry deposition. If released to soil, titanium compounds are expected to be immobile. Titanium compounds are not expected to volatilize from moist or dry soil surfaces based upon their ionic character and low vapor pressures. If released into water, soluble titanium ions are easily hydrolyzed into hydrated titanium oxides and basic oxo salts which are insoluble. Volatilization from water surfaces is not expected to be an important fate process because dissolved titanium compounds are ionic and ions are not expected to volatilize (USNLM, 2003).

Titanium compounds are not expected to bioconcentrate in aquatic organisms (USNLM, 2003). A study done on two organisms such as rats and guinea pigs showed titanium encapsulated with fibrous tissue, and increased rates in fibrosarcomas and lymphosarcomas (USNLM, 2003).

Human Hazards. Occupational exposure to titanium compounds may occur primarily by the inhalation dust at workplaces where titanium compounds are produced or used. Monitoring data indicate that the general population may be exposed to titanium compounds via inhalation of ambient air, ingestion of food, and dermal contact with consumer products containing titanium compounds (USNLM, 2003). Potential health effects associated with exposure are eye and skin irritation. Exposure by ingestion may

cause gastrointestinal irritation with nausea, vomiting and diarrhea; while exposure by inhalation may cause respiratory tract irritation. The toxicological properties of this substance have not been fully investigated. Food is the principal source of exposure to titanium. Typical diets in the United States provide approximately 300 µg of titanium daily. The PEL recommended by OSHA and ACGIH are 10 mg/m^3 (as TiO_2 for total dust) (Dungan, 2003). Titanium is not listed as a carcinogen by OSHA, NTP, or NIOSH (Acros Organics, 2001).

10.0 ROCKET PROPELLANTS

Rocket propellants are a chemical mixture burned to produce thrust in rockets and consist of a fuel and oxidizer. A fuel is a substance which burns when combined with oxygen producing gas for propulsion. An oxidizer is an agent that releases oxygen for combination with a fuel. Rocket propellants can vary from liquid, solid, and hybrid propellants. Rocket propellants are safe to handle, have a long shelf life, their energy density is high, and the propagation of the explosion is very fast. This is accomplished with a small quantity of a primary explosive and additive. Modern and extremely insensitive formulations have been developed in most countries to eliminate accidents with these propellants. Apart from insensitive energetic compounds, new inert or energetic binder systems are being introduced to improve the vulnerability.

Ammonium Perchlorate/Aluminum/binder propellants (AP/Al)

Descriptive summaries for each compound are found under Energetic/Reactive Materials

Inhibited Red Fuming Nitric Acid (IRFNA) [CAS 7697-37-2]

General Information. IRFNA is found to contain more than 85% nitric acid and approximately 15% NO (nitrogen oxide) and less than 5% water. It is generally found as a white to slightly yellow liquid that darkens to a brownish color upon aging and exposure to light. IRFNA is found to be soluble in water, decomposes in alcohol, and is corrosive. Its uses have been seen in preparation of nitrocompounds, rocket fuels, and laboratory reagents (Lewis, 1993). It is found to be a strong oxidizer and contact with other material may cause a fire (Fisher, 2001a).

Environmental Fate and Hazards. In water, elevated nitrate levels will stimulate plankton and aquatic weed growth. When nitric acid enters the soil, it will dissolve some of the soil material and will be neutralized to some degree. Significant amounts of acid are expected to remain for transport down toward the groundwater table. The acid will move in the direction of the groundwater flow. IRFNA will be gradually neutralized by hardness minerals (calcium and magnesium) in water. The nitrate ion may persist longer, but will ultimately be consumed as a plant nutrient (USNLM, 2003).

The concentration of IRFNA affected the mortality of bluegill over 96 hours by 50 %, with a sub-lethal concentration of acid, bluegill became hypoactive with respect to their swimming behavior (Ellgaard, 1984). Acute toxicity to fingerling rainbow trout was measured in a 7-day bioassay and the medium lethal concentration was approximately at

pH 4.0. The fish died at a low pH (3.0-4.0) and exhibited classical symptoms of acid toxicity. Comparison of the present results with other toxicity measurements suggests that nitric acid has intermediate toxicity between sulfuric acid and hydrochloric acid at pH 3.0 and less toxic than either acid at pH greater than or equal to 3.3 (Swift, 1983).

IRFNA is considered teratogenic, the effects on newborn rats from IRFNA were biochemical and metabolic with an oral TDLo of 2345 mg/kg (female 18 day post). Fetotoxicity was prevalent by a stunted fetus with a TDLo of 21150 mg/kg (female 1-21 day post) (oral) (Fisher, 2001). The LC_{50} by inhalation on a rat was 260 mg/m^3/30 min., 130 mg/m^3/4 hr and 67 ppm (NO_2)/4 hr (Nitric acid MSDS).

Human Hazards. Occupational exposure to IRFNA may occur primarily at workplaces where IRFNA are produced or used such as aircraft workers, ammonium nitrate makers, bleachers, brass cleaners, bright dip workers, and cellulose nitrate makers to name a few (Lewis, 1993). IRFNA is corrosive causing severe eye and skin burns along with possible severe digestive and respiratory tract burns. IRFNA target organs were found to be the respiratory system, gastrointestinal system, teeth, eyes, skin, and mucous membranes. It is not found to be carcinogenic by ACGIH, IARC, NIOSH, NTP, or OSHA (Fisher, 2001a). The established PEL was found to be 2 ppm TWA (ACGIH, NIOSH, and OSHA).

Discussion. Test personnel exposed to IRFNA will be at no risk if proper PPE is used. IRFNA is not expected to have any impact on the general population. IRFNA is not expected to have any impact on terrestrial or aquatic environments at and near DTRA test beds (Figure 10-1). IRFNA is water soluble and has the potential to leach into groundwater. IRFNA is not likely to adsorb to sediment or soil due to its solubility.

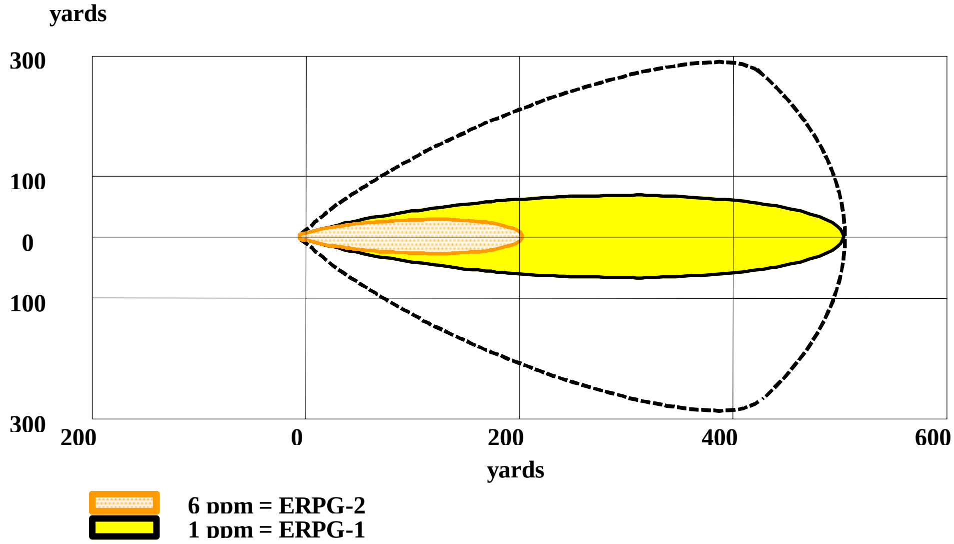

Figure 10-1. Plume Model of Inhibited Red Fuming Nitric Acid (IRFNA) spill (ALOHA, 2004).

Nitrate Ester propellants

- **Nitrocellulose**
- **Nitroglycerin**

Nitrocellulose [CAS 9004-70-0]

General Information. Nitrocellulose is a colorless, syrupy liquid with an ether-like odor (USNLM, 2003). It is usually formed by the action of a mixture of nitric and sulfuric acids on purified cotton or wood pulp. The extent of nitration and degradation (breaking down) of the cellulose is carefully controlled in order to obtain the desired product. When cotton is treated so that nearly all of the hydroxyl groups of the cellulose molecule are esterified, but with little or no degradation of the molecular structure, the nitrocellulose formed is called guncotton. Guncotton resembles cotton in its appearance. Extremely flammable, it explodes when detonated and is used in the manufacture of explosives. Guncotton is insoluble in such common solvents as water, chloroform, ether, and ethanol. If the nitration is not carried to completion (the point at which about two thirds of the hydroxyl groups are esterified), the soluble cellulose nitrate pyroxlin is formed .

Environmental Fate and Hazards. Degradation of nitrocellulose involves a complex chemical dissociation into a wide variety of products. Extremely high concentrations of NO_3/NO_2 are present in leachate from nitrocellulose landfills. Low permeability of the

sludge and especially soil/sludge mixture will attenuate the effect over a longer time frame. The acute oral LD_{50} for rats was greater than 5 gm/kg (USNLM, 2003).

Human Hazards. Occupational exposure to nitrocellulose may occur through dermal contact with this compound at workplaces where nitrocellulose is produced or used. The general population is not expected to be exposed to nitrocellulose. It is moderately toxic: probable oral lethal dose to a human can consist of 0.5-5.0 g/kg, between 1 ounce and one pint (or 1 lb) for a 70 kg person (150 lb) (USNLM, 2003). No OEL has been established by either OSHA or NIOSH. Nitrocellulose is not listed as a carcinogen by NTP.

Nitroglycerin [CAS 55-63-0]

General Information. Nitroglycerin's production and use as a propellant and explosive, and as a pharmaceutical product to treat heart related illness, may result in its release to the environment through various waste streams.

Environmental Fate. If released to air, a vapor pressure of 2.0×10^{-4} mm Hg (20 °C) indicates nitroglycerin will exist in both the vapor and particulate phases in the ambient atmosphere. Vapor-phase nitroglycerin will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 15 days. Nitroglycerin absorbs light weakly in the environmental UV spectrum, but it is unknown whether it undergoes significant direct photolysis in the atmosphere. Particulate-phase nitroglycerin will be removed from the atmosphere by wet and dry deposition. If released to soil, nitroglycerin is expected to have moderate mobility based upon an estimated K_{oc} of 180. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 4.3×10^{-8} atm-cu m/mole. If released into water, nitroglycerin is expected to adsorb to suspended solids and sediment based upon the estimated K_{oc}. Nitroglycerin was completely biodegraded in 13 days using river water and river water/sediment microcosms obtained from a river near a munitions facility. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's estimated Henry's Law constant. Although hydrolysis is not an important environmental fate process at neutral pH, hydrolysis may be important under alkaline conditions based on half-lives of 37 and 96 days at pH 9 and 25 and 18 °C, respectively. Nitroglycerin may undergo photolysis in sunlit surface waters. The photolysis half-life for nitroglycerin in distilled water, filtered river water and filtered pond water exposed to sunlight were 116, 57 and 73 days, respectively. An estimated BCF of 4 suggests the potential for bioconcentration in aquatic organisms is low.

Human Hazards. Occupational exposure to nitroglycerin may occur through dermal contact with this compound at workplaces where nitroglycerin is produced or used. The general population is not expected to be exposed to nitroglycerin except for persons that may need to use this compound to treat and prevent chest pain (from angina pectoris), or other heart related conditions. The PEL is 0.2 ppm (2 mg/m^3) (NIOSH, 2003). It is not listed as a carcinogen by NTP.

Triamino-trinitrobenzene (TATB) [CAS 3058-38-6]

General Information. Triamino-trinitrobenzene (TATB) is a yellow powder that is odorless and its solubility is negligible in water (Heracules, 1995). Trinitrotoluene is selectively reduced by reaction with H_2S in p-dioxane to produce 4-amino-2, 6-dinitrotoluene. This latter compound is then nitrated with HNO_3 in H_2SO_4 to produce pentanitroaniline which is, in turn, reacted with NH_3 in benzene, methylene chloride or another suitable solvent to produce triaminotrinitrobenzene. TATB is a useful explosive used in military applications.

Environment Fate and Hazard. Acute oral LD_{50} for a rats and mice was greater than 5 g/kg, while the lethal concentration for rats was greater than 212 mg/m^3/1 hour. The toxic effects seen in the rat were acute pulmonary edema in the lungs, thorax, and hemorrhaging. Hazardous decomposition products that are produced are phenol, dimethybenzene, and several carboxylic acids and phthlatates have been found in samples of explosion debris.

Human Hazards. TATB is a mild, transient irritant to the eye and possibly an irritant to skin, respiratory, and digestive systems. No OEL has been established and it is not listed as a carcinogen (U.S Department of Health and Human Services, 2002).

Unsymmetrical Dimethyl Hydrazine (UDMH) [CAS 57-14-7]

General Information. UDMH is a clear, light yellow liquid that is miscible in water. It is found to be a corrosive. UDMH is a component in jet and rocket fuels, in chemical synthesis, as a stabilizer for organic fuel additives. Other uses have included as an absorbent for acid gases, in photography and as a plant growth control agent which may result in its release to the environment through various waste streams.

Environmental Fate and Hazard. In the atmosphere, UDMH will exist solely in the vapor phase in the ambient atmosphere and is expected to react very quickly with ozone in the troposphere with an estimated half-life of 16.5 min for the reaction between vapor phase UDMH and ozone. Vapor-phase UDMH is degraded in the atmosphere slowly by

reaction with photochemically-produced hydroxyl radicals with an estimated half-life of about 6 days. UDMH will generally be mobile in most soils. Leaching of this compound may result upon release of UDMH to sandy soil; some degradation and adsorption to soils containing clay and organic carbon may occur. UDMH may also undergo direct photolysis in soil and water surfaces since hydrazines strongly absorb UV light in the environmentally significant range (> 290 nm). Volatilization from moist soil surfaces is not expected. The potential for volatilization of UDMH from dry soil surfaces may exist based on its vapor pressure. If released in the water, UDMH is expected to result in oxidation at a rate directly proportional to the pH with half-lives of 3.9 to 630 hours at pH values of 9 to 5. The estimated half-lives of UDMH in pond water and seawater based upon experimental results are 16.3 to 22.2 and 12.6 days, respectively. Based on soil studies, UDMH should not adsorb to sediment and particulate matter in water. This compound is not expected to volatilize from water surfaces (USNLM, 2003). Hazardous decomposition products are nitrogen oxides, carbon dioxide, nitrogen, carbon monoxide, and irritating and toxic fumes and gases.

Bioconcentration in aquatic organisms should be low based on an estimated BCF value of 0.1 (USNLM). Different studies found UDMH to be slightly to moderately toxic. Average LC_{50} study values varied from 11,350 µg/L in channel catfish (*Ictalurus punctatus*), 34,000 µg/L in golden shiner (*Notemigonus crysoleucas*), 7,850 µg/L in fathead minnow (*Pimephales promelas*), and 40,250 µg/L in guppy (*Poecilia reticulate*). In amphibians, an average LC_{50} value of 87,894 µg/L was found for salamanders (*Ambystoma*) and in zooplankton (*Hyalella azteca)* UDMH was found to be slightly toxic at 4700 µg/L (EPA).

Human Hazards. The general population may be exposed to UDMH via ingestion of food. Occupational exposure may occur through inhalation or dermal contact at workplaces, where UDMH is produced or used. Occupational exposure was seen in the production of aerospace fuels, in chemical synthesis, and photography. When exposed UDMH causes eye and skin burns and if absorbed through the skin possibly cause central nervous system depression. If inhaled it may cause severe respiratory tract irritation with possible burns and may cause severe digestive tract irritation with possible burns. Established permissible exposure levels (PEL) are 0.01 ppm TWA (skin - potential for cutaneous absorption) ACGIH, 15 ppm IDLH NIOSH, and 0.5 ppm TWA (1 mg/m^3 TWA) OSHA. UDMH been deemed a carcinogen by ACGIH, NIOSH, and OSHA (Acros Organics, 2003).

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11.0 NON-ENERGETIC MATERIAL

Munitions with alternative payloads to conventional high explosives are used to disable equipment or personnel by various biological, chemicals, abrasives, foams, and similar substances are non-energic. The proposed materials will be used only inside a facility such as an underground tunnel, or bunker type complex. Non-energetic weapons are used to make an attacked facility uninhabitable, without necessarily causing lethal effects. Tests conducted would affect small (mainly enclosed) areas in the DTRA test beds. The toxicity of non-energetic weapons toxicity is minimal to humans, fauna, and flora from the available research. Non-energetic weapons include butyric acid, carbon fibers, ethyl mercaptan, and benzyl mercaptan to name a few.

Alumina (Aluminum oxide) [CAS 1344-28-1]

General Information. Alumina is widely distributed in nature and commercially important. When manufactured, it is a white powder and insoluble. A major use is in the production of aluminum metal. It is also used for abrasives; corundum and emery are widely used, as are artificially prepared alumina abrasives. Alumina is also used in ceramics, in pigments, and in the manufacture of chemicals. Clays containing alumina are used in porcelain, pottery, and bricks. Pure alumina is used in making crucibles and other refractory apparatus. It is also used in glassmaking, cosmetics, medicine as an antacid, aluminum metal, abrasives, and other products (USNLM, 2003).

Environmental Fate and Hazards. The adsorption of aluminum by fine particulates was studied in Whitray Beck, a hill stream in England. Uptake of aluminum by the particles increased with total aluminum, with pH, and with particle concentration, although the fraction of aluminum bound at a given pH and particle concentration decreased with total aluminum. Albic and spodic soil horizons were sampled from old growth eastern white pine/mixed northern hardwoods sites in the Adirondacks, and an ochric soil horizon was sampled from the Appalachian Plateau of NY State. Three horizon forest floor, 9 mineral soil (field moist equivalent of 12.0 oven dry albic, spodic, or ochric mineral soil) and 9 forest floor/mineral soil columns were leached with 60 ml of (a) 10 mM ammonium nitrate (control), (b) 1.0 mM nitric acid in 10 mM ammonium nitrate (pH 3), and (c) 1.0 mM ammonium nitrate (pH 3) at the rate of 10 ml/hr. The above procedure was repeated on each mineral soil without a forest floor, except leaching solution were 0.5 mM calcium nitrate or calcium sulfate, each in 10 mM ammonium nitrate. Adding 2 and 0.5 cmol sub c (H+)/kg to forest floor and mineral soils, respectively, simulated snowmelt additions. Total aluminum concentration in leachates from forest floor/albic or forest floor/ochric columns were greater than the sum of concentration in leachates from the forest floor and mineral horizon when leached separately. This positive synergistic

behavior of the forest floor mineral horizon sequences was also observed in the forest floor spodic horizon sequence when leached with control solution, but the synergism was negative for both labile and non-labile aluminum when leached with the acids. Sulfuric acid leached less aluminum from the spodic horizon than did nitric acid, regardless of the presence of a forest floor, but nitric acid, sulfuric acid, and control solution leached similar concentration of aluminum from the albic and ochric horizons. The forest floor effects on the mineral soil leachates were attributed to effects of calcium, sulfate, nitrate, and dissolved organic carbon leached from the forest floor to the mineral horizon since forest floor removed nearly all added hydrogen . Aluminum oxide is highly persistent in water, with a half-life greater than 200-days (USNLM, 2003).

Human Hazards. No human and animal studies have found it to be carcinogenic. The PEL for alumina is 15 mg/m^3 (total) and 5 mg/m^3 (resp.) (NIOSH, 2003). Exposure to alumina causes irritation in the eye, skin, respiratory and digestive systems. Aluminum content of a normal human brain ranged from 0.1 to 3.9 µg/g dry weight.

Discussion. Alumina is widely produced and distributed and commercially important. Exposure will occur where it is produced/used, occupational workers will have a higher probability of exposure whereas the general population will not. Alumina hazard is principally that of a nuisance dust. Coughing or shortness of breath may occur in cases of excessive inhalation, while skin redness and some pain may accompany irritation. The use of protective equipment (such as goggles and respirator) will minimize exposure to alumina.

Alumina is a widely distributed natural inorganic compound that is insoluble in water. Due to its insolubility, it will have the potential to bioaccumulate in the environment and absorb to the soil. It will not likely leach into the groundwater due to its water solubility.

Benzyl mercaptan [CAS 100-53-8]

General Information. Benzyl mercaptan is a colorless liquid with a garlic-like odor. It is insoluble in water, but soluble in alcohol and carbon disulfide (Lewis, 1993). It is found naturally in coffee, and it originates from a weed and at times is found in grasslands. Benzyl mercaptan is used as a flavoring agent and as an odorant (USNLM, 2002).

Environmental Fate and Hazards. Benzyl mercaptan will exist solely as a vapor in the ambient atmosphere based on an estimated vapor pressure of 0.47 mm Hg (25 ºC). Vapor-phase benzyl mercaptan will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 9 hours. Benzyl mercaptan does contain chromophores that absorb at

wavelengths greater than 290 nm and therefore is expected to be susceptible to direct photolysis by sunlight.

Benzyl mercaptan is expected to have low mobility in soil based on an estimated K_{oc} of 520. Volatilization from moist soil surfaces is expected to be an important fate process based upon an estimated Henry's Law constant of 2.1 x 10^{-4} atm-cu m/mole. Benzyl mercaptan is not expected to volatilize from dry soil surfaces based upon its vapor pressure.

Benzyl mercaptan is expected to adsorb to suspended solids and sediment based on an estimated K_{oc}. Biodegradation data were not available. Volatilization from water surfaces is expected to be an important fate process based upon this compound's estimated Henry's Law constant. Volatilization half-lives for a river and lake model are 8 hours and 6 days, respectively. An estimated BCF of 16 suggests the potential for bioconcentration in aquatic organisms is low. Hydrolysis is not expected to be an important environmental fate process since this compound lacks functional groups that hydrolyze under environmental conditions. Acute oral LD_{50} for rats was 493 mg/kg. Benzyl mercaptain oxidizes in air to dibenzyl disulfide (Acros Organics, 2003).

Human Hazards. ACGIH, IARC, NIOSH, NTP, or OSHA does not list benzyl mercaptan as a carcinogen, but it was found to be toxic to humans. It causes skin and eye irritation, and is harmful if swallowed or absorbed through the skin. It may cause respiratory and digestive tract irritation. No OEL has been established, but Chevron Chemicals recommends a PEL of 0.5 ppm (8-hour TWA) for benzyl mercaptan in their material safety data sheet (Chevron, 2002).

Occupational exposure to benzyl mercaptan may occur through inhalation and dermal contact with this compound at workplaces where benzyl mercaptan is produced or used. Use data indicate that the general population may be exposed to benzyl mercaptan ingestion of food products containing benzyl mercaptan as a flavoring.

Boron trifluoride (BF_3) [CAS 7637-07-2]

General Information. Boron trifluoride is a colorless gas. It is soluble in cold water, but hydrolyzes in hot water. It is soluble in concentrated sulfuric acid and most organic solvents. It easily forms double compounds such as these with ether, known as boron trifluoride etherate or BF_3-ether complex. It is used as catalysts in organic synthesis, production of diborane, instruments for measuring neutron intensity, soldering fluxes, and gas brazing (Lewis, 1993).

Environmental Fate and Hazards. Iron and aluminum hydroxyl compounds and clay minerals adsorb some boron. Finer textured soils retain added boron longer than do coarse, sandy soils. Boron sorption by clay minerals and iron and aluminum oxides is pH dependent, with maximum sorption in the range 7-9. The amount of boron adsorbed depends on the surface area of the clay or oxide and this sorption is only partially reversible. In seawater, boron is found at 4.5 µg/g (as total boron), while in the soil boron is found at 3-10 µg/g (USNLM, 2002).

Boron trifluoride decomposes in hot water yielding hazardous decomposition product hydrogen fluoride. An LC_{50} on rats by inhalation was 1180 mg/m^3 for 4 hours and for guinea pigs were 109 mg/m^3/4 hours. Lethal concentration by inhalation was greater than 1000 ppm/3 hours for dogs. The effects that resulted were respiratory depression, hemoraging, white blood count change, and respiratory structural or functional change in trachea or bronchi (NIOSH, 2003).

Human Hazards. It is toxic by inhalation and corrosive to skin and tissue. The PEL established by NIOSH and OSHA are 1 ppm (3 mg/m^3) TWA (NIOSH, 2003). NIOSH estimates 50,000 employees are potentially exposed in the United States. At high concentration, boron trifluoride causes burns to skin similar to those caused by hydrogen fluoride, although boron trifluoride burns do not penetrate as deeply as do hydrogen fluoride burns (USNLM, 2002). Severe exposures can lead to severe irritation of the eyes and eyelids and to inflammation and congestion of the lung and circulatory collapse. Skin contact with the liquid or vapor can cause severe burns. It is not listed or known as a carcinogen by NTP (U.S Department of Health and Human Services, 2002).

Discussion. Test personnel exposed to BF_3 will be at no risk if proper PPE is used. BF_3 is not expected to have an impact on general population. BF_3 could have an impact on small terrestrial or aquatic environments at and near DTRA test beds. Movement of the plume across the test area is unlikely to affect civilian populations because the concentration of BF_3 is likely to be very low at that point (Figure 11-1).

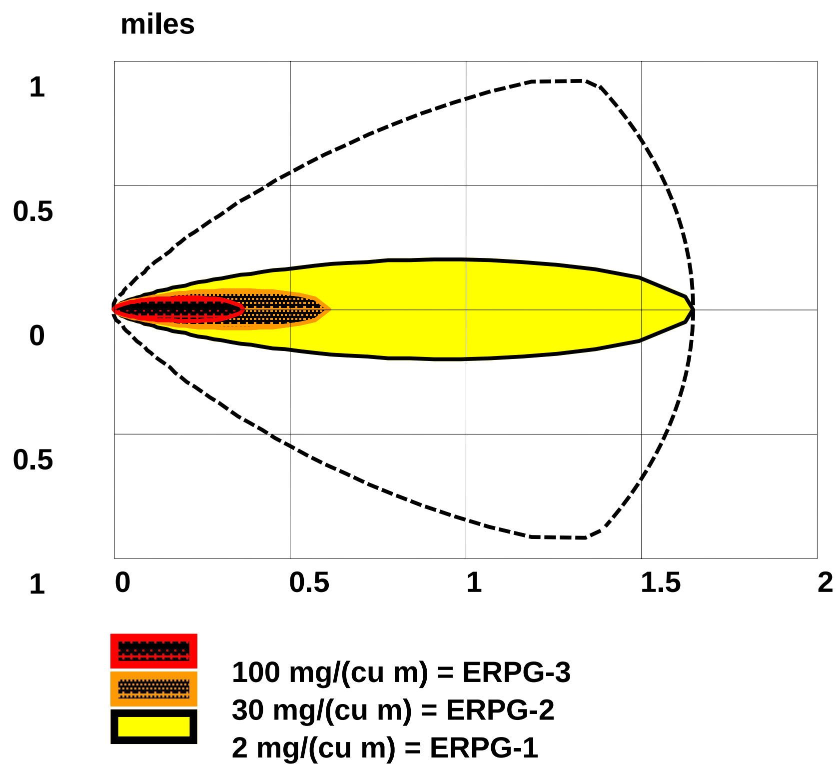

Figure 11-1. Predicted plume model for boron trifluoride (ALOHA, 2004).

Bromine [CAS 7726-95-6]

***General Information**:* Bromine is a reddish to brown liquid with suffocating, irritating fumes. Its taste threshold is between 0.17 - 0.23 mg/l (as bromide) in water at a pH 5-9. It is highly corrosive liquid. Its solubility is 0.31 g in 100 g water (0 °C) and 3.5 g/100g (30 °C) (USNLM, 2002). The most common inorganic bromides are sodium, potassium, ammonium, and calcium bromides. It reacts vigorously with aluminum and explosively with potassium. It is used in fire-retardant for plastics, in photography, shrink-proofing wool, organic synthes, and as is intermediate for fumigants and fire-extinguishing fluid.

Environmental Fate and Hazards. The halons are used as fire extinguishing agents, both in built-in systems and in handheld portable fire extinguishers. Halon production in the U.S. ended on December 31, 1993 because they contribute to ozone depletion. They cause ozone depletion because they contain bromine. Bromine is many times more effective at destroying ozone than chlorine. At the time the current U.S. tax code was adopted, the ozone depletion potentials of halon 1301 and halon 1211 were observed to be 10 and 3, respectively. These values are used for tax calculations. Recent scientific studies, however, indicate that the ODPs are at least 12 and 6, respectively. Note: technically, all compounds containing carbon and fluorine and/or chlorine are halons, but in the context of the Clean Air Act, "halon" means a fire extinguishing agent as described

above. Halons are numbered according to a standard scheme (EPA, 2004). Bromine (Br_2) will photolyze rapidly (about 1 minute) to form Br atoms, which then react with ozone to ultimately form aerosol and/or particulate bromine. No information on the atmospheric half-life and lifetime of bromine was found in the readily-available literature.

Human Hazards. Inhalation of bromine vapors may produce chemical pneumontis. Symptoms associated with this are coughing, nosebleeding, feeling of depression, dizziness and headache. Bromine is a lacrimator at concentrations below 6.5 mg/m^3. At 10 ppm, bromine gas is a severe irritant and cannot be tolerated, while at 2.10 mg/m^3 it was found also to be irritating. The PEL is 0.1 ppm (0.7 mg/cu m), while the 8 hour TWA is 0.1 ppm, and the 15-minute STEL is 0.2 ppm (UNNLM, 2002). NIOSH found that an exposure of 3 ppm can be immediate danger to life or health (USNLM, 2002). At the present time bromine is not listed as a carcinogen. Experiments in animals have shown that potassium bromate given in drinking water causes kidney tumors and mesotheliomas. The carcinogenic potential of potassium bromate is under review by the EPA. The IARC has classified potassium bromate in Group 2B: Possible human carcinogen, based on the absence of data in humans and sufficient evidence in experimental animals.

The State of California has determined under Proposition 65 that potassium bromate is a carcinogen (CCR, 1996). The inhalation potency factor that has been used as a basis for regulatory action in California is 1.4 x 10^{-4} µg/m^3. In other words, the potential excess cancer risk for a person exposed over a lifetime to 1 µg/m^3 of potassium bromate is estimated to be no greater than 140 in 1 million (Environmental Defense, 2004).

Bromine Trifluoride (BrF_3) [CAS 7787-71-5]

General Information. Bromine trifluoride is a colorless to yellow or gray fuming liquid with an irritating odor. It is soluble in sulfuric acid and reacts violently in water. Little is currently known about bromine trifluoride as (Rozen and Iris Ben-David described 2001). It is used as a fluorinating agent and as an electrolytic solvent (Lewis, 1993).

Environmental Fate and Hazard. Hazardous decomposition products are bromine, fluorine, bromine monofluoride, and hydrogen fluoride. Bromine trifluoride is considered as a toxic and reactive highly hazardous chemical that could present a potential for a catastrophic event at or above the threshold quantity (OSHA, 1993).

Human Hazard. Exposure may be irritating and corrosive to all living tissues. Toxic level exposure to skin tissue caused hydrofluoric acid burns and skin lesions resulting in tissue destruction and eventual scarring. Burn activity continues while any residual active

fluorides remain. When inhaled, symptoms include lachrymation, cough, difficult breathing, and abnormal fluids formation in the nose, mouth and throat. Inhalation of BrF_3 may cause pneumonitis and pulmonary edema that could be fatal. Symptoms of hydrofluoric acid burns are severe pain, redness, and possible swelling and tissue destruction. Burns of the eye result in lesions and possible loss of vision. Extended low-level systemic absorption of fluorides may cause fluorosis, an abnormal calcium accumulation in the bone structure. PELs are as inorganic fluorides 2.5 mg/m^3 OSHA TWA, 2.5 mg/m^3 ACGIH TWA, and 2.5 mg/m^3 NIOSH recommended TWA 10 hour(s) (Matheson Tri-Gas, 2002). Bromine trifluoride is listed as a hazardous chemical and extra care should be taken. It is not listed or known as a carcinogen by NTP (U.S Department of Health and Human Services, 2002).

Butyl mercaptan [CAS 109-79-5]

General Information. Butyl mercaptan is a colorless liquid with an obnoxious, strong, garlic-like odor. Water solubility is 595 mg/L (25^{o}C) and it is soluble in alcohol, ether and liquid hydrogen sulfide. It is used for insecticides, acaricides, herbicides, defoliants, and as a solvent (USNLM, 2003).

Environmental Fate and Hazards. If released in the soil, n-butyl mercaptan will partially evaporate and partially leach into the soil and possibly into the groundwater. The occurrence of biodegradation in soil has not been established. If released in water, n-butyl mercaptan will primarily be lost through evaporation (5 hr half-life in a typical river). Some adsorption to sediment would also be expected. If released in air, n-butyl mercaptan will degrade by reaction with photochemically produced hydroxyl radicals (estimated half-life 1.6 days). Due to its relatively high vapor pressure, n-butyl mercaptan would readily volatilize from soil and other solid surfaces.

No experimental values BCF could be found in the literature, a value of 1.5 can be estimated using its log octanol/water partition coefficient. Therefore, no appreciable bioconcentration in fish would be expected. Little information is available in the literature on the biodegradation of n-butyl mercaptan. *Alcaligenes faecalis*, a microorganism identified as a member of activated sludge flora, oxidizes n-butyl mercaptan and other low molecular weight mercaptans. Methyl mercaptan is oxidized by microbial populations in anaerobic freshwater sediment and anaerobic sewage sludge, although no data are available for higher molecular weight mercaptans such as n-butyl mercaptan. Acute oral and interpertial LD_{50} for rats was 2575 mg/kg and 679 mg/kg. The LC_{50} for rats and mice was 4020 ppm over 4 hrs and 2500 ppm over 4 hrs.

Human Hazards. It is not listed as a carcinogenic (U.S Department of Health and Human Services, 2002). Symptoms associated with butyl mercaptan are irritation to eye and skin. If ingested, it may cause gastrointestinal irritation with nausea, vomiting and diarrhea. Butyl mercaptan is a known mercaptan which may cause nausea and headache. Exposure to high concentrations of mercaptans can produce unconsciousness with cyanosis (bluish discoloration of skin due to deficient oxygenation of the blood), cold extremities and rapid pulse. If inhaled, it may cause respiratory tract irritation and vapors may cause dizziness or suffocation. It may produce nausea in low concentration and pulmonary edema in high concentrations. The PELs are 0.5 ppm (ACGIH TWA), 10 ppm (35 mg/m^3 OSHA PEL), 0.5 ppm (1.8 mg/m^3 15 minutes) and 500 ppm (NIOSH IDLH) (NIOSH, 2003; ACGIH, 2001).

Discussion. Test personnel exposed to butyl mercaptan will be at no risk, if proper PPE is used. The plume model shows butyl mercaptan concentration will be kept to a minor area (Figure 11-2). Butyl mercaptan is not expected to have any impact on the general population.

Butyl mercaptan is not water-soluble and is unlikely to leach into groundwater.

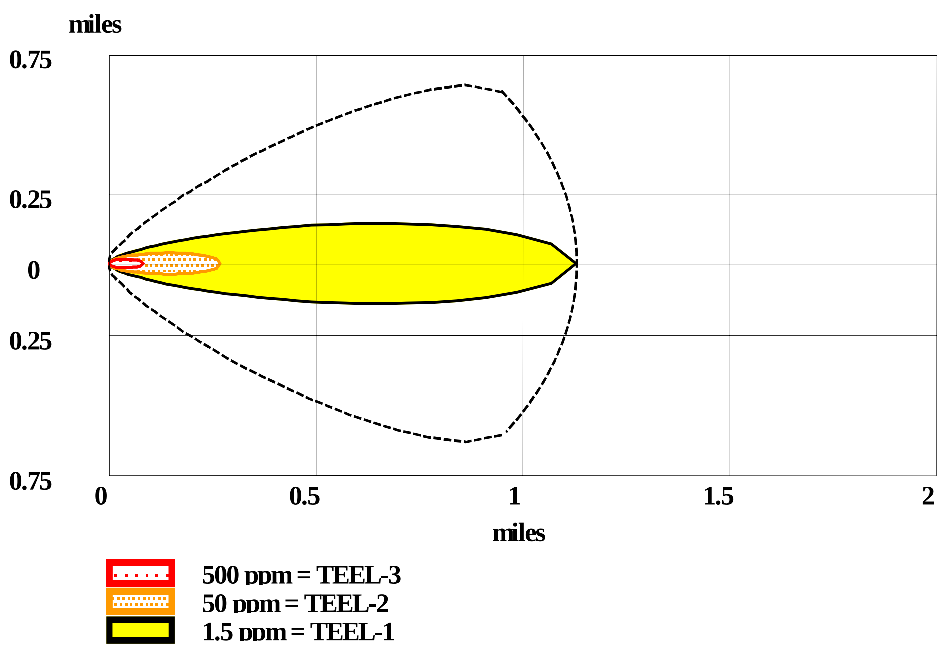

Figure 11-2. Predicted plume model for butyl mercaptan (ALOHA, 2004).

Butyric Acid [CAS 107-92-6]

General Information. Butyric acid is both a natural and a commercially produced organic compound. Butyric acid is a colorless liquid with a penetrating and obnoxious odor. It is miscible in water, alcohol, and ether and is combustible. It is naturally occurring as a glyceride in animal milk fats, and present in butter as an ester to extent of 4-5%. It is found in vegetable oils and animal fluids (USNLM, 2002). Its primary uses are synthesis of butyrate ester perfume and flavor ingredients, pharmaceuticals, deliming agent, disinfectants, emulsifying agents, and sweetening gasoline (Lewis, 1993).

Environmental Fate and Hazards. Experimental soil studies show that butyric acid may be relatively mobile in soil. Any adsorption of butyric acid to soil is driven by attractive interactions with active sites in the soil and not due to hydrophobic characteristics, which indicates that it will not significantly volatilize from either moist or dry soil to the atmosphere. Butyric acid is expected to biodegrade rapidly under both aerobic and anaerobic conditions in the water. The half-life for volatilization from a model river at 1 m deep(flowing at 1 m/sec and a wind speed of 3 m/sec) is 59 days. An experimental K_{oc} value obtained using lateritic muddy sand indicates that butyric acid will not significantly adsorb to sediment and suspended organic matter. In the atmosphere, butyric acid is expected to undergo a gas-phase reaction with photochemically produced hydroxyl radicals with a half-life is of 8 days. Butyric acid is miscible with water and it may undergo atmospheric removal by wet deposition (USNLM, 2002).

A BCF of 2.3 indicates that it is not likely to bioconcentrate in fish and aquatic organisms (USNLM, 2002). In fish, such as the Bluegill Sunfish (*Lepomis macrochirus*) the LC_{50} is 200 mg/L over 24 hours, unspecified flea median effective concentration (EC_{50}) is 61 mg/L over 48 hours; unspecified ria, Phytobacterium phosphoreum EC_{50} was 16.9 to 17.2 mg/L at 5, 15, and 30 minutes using the microtox test (Butyric Acid, 2003). Acute oral LD_{50} for rat was 2mg/kg and the skin LD_{50} for rabbit was 530 µL/kg. The draize test on rabbit skin was 20 mg/24 hours resulting in moderate exposure. An undetermined prolonged exposure of mice, rats, and rabbits caused an increase in circulating lymphocytes and neutrophils, attributed to the irritant nature of the compound. Studies on different cells determined that cell growth was inhibited (USNLM, 2002).

Human Hazards. Occupational exposure to butyric acid may occur by inhalation or dermal contact during its production or use. Exposure to the general public may occur by inhalation or dermal contact, if commercial products containing this compound are used in the home. Ingestion of butyric acid is a probable route of exposure due to its presence in foods (USNLM, 2002). It may cause severe to permanent damage to the digestive tract

when ingested. It causes burns when exposed to the eyes or skin. If inhaled, it may cause severe irritation of the respiratory tract with pain, burns, and inflammation or chemical burns (Fisher Scientific, 2003a). It has been found to cause DNA damage (Fisher Scientific, 2003a). An OEL has not been established for butyric acid and OSHA or NIOSH does not list it as a carcinogen.

Calcium Oxide [1305-78-8]

General Information. When manufactured, calcium oxide appears as crystals that are white or grayish white lumps, or granular powder and found to be odorless. It is soluble in water, acids, glycerol, but practically insoluble in alcohol. Its uses are for the manufacture of bricks, plaster, mortar, stucco, and other building materials. Other uses include the manufacture of calcium salts, the adsorption of carbon dioxide, and the treatment of water and sewage (USNLM, 2003).

Environmental Fate and Hazards. This chemical is expected to be toxic to aquatic life. In the mosquito fish (*Gambusia affinis*) and sunfish (*Lepomis sp.*), calcium oxide is toxic at 240 ppm/24hr and at 100 ppm/3hr, while in the vector snail it was found to be lethal at 300 ppm/24hr (Quikrite, 2004). No hazardous decomposition products were found to be associated with this chemical.

Human Hazards. Occupational exposure to calcium oxide may occur through dermal contact with this compound at workplaces where calcium oxide is produced or used. The general population may be exposed due to the use of consumer products containing this compound. During lime production, workers may be exposed to atmospheric dust. Dust is a hazard in manual crushing, screening, drying, packaging, and loading of lime itself, to builders, plasterers, and agricultural workers. Calcium oxide dust irritates the eyes and upper respiratory tract primarily because of its alkalinity. Inflammation of the respiratory passages, ulceration and perforation of the nasal septum, and pneumonia have been attributed to inhalation of calcium oxide dust.The PEL for calcium oxide is 5 mg/m^3 (OSHA) and 2 mg/m^3 (NIOSH, 2003). Calcium oxide is not listed as a carcinogen by NTP, IARC, or OSHA (USNLM, 2003).

Carbon Fibers and Nanotubes, Various Sizes

General Information. Carbon is nonmetallic element that is found in all organic and a few inorganic compounds (such as carbon oxides, carbon disulfide, and metallic carbonates such as calcium carbonate). It is found to be insoluble in water and is odorless. An active element in photosynthesis and occurs in all plant an animal life. With its unique properties and uses, is found in the manufacture of different components. The

radioisotope ^{14}C is used in tracer research and chemical dating. Carbon is a strong reducing agent used in purification of metals and is one of the few chemicals that can form four covalent bonds. With its strong electrical conductivity characteristic it is used for electrodes and other electrical components (Lewis, 1993).

Environmental Fate and Hazards. Carbon occurs in three forms: graphite, amorphous carbon such as coal, lampblack and the various forms of artificial carbon. Distributed widely in nature, it is found in abundance in sun, stars, comets, and atmospheres of most planets.

Experimental intravenous injection of pure carbon suspension in rabbits produces no ocular inflammation, although carbon particles were deposited within the blood vessels. Small quantities of carbon suspensions in the form of graphite or India ink injected into the anterior chamber of rabbits is mostly taken up by leukocytes and by the corneal endothelium, producing essentially no signs of inflammation (USNLM, 2003). Acute intravenous LD_{50} for a rat was 440 mg/kg.

Human Hazards. Routes of exposure are by inhalation, skin and/or eye contact. Symptoms include cough, dyspnea (breathing difficulty), black sputum, decreased pulmonary function, and lung fibrosis. Target organs are the respiratory and cardiovascular system. Inhalation of carbon dust can immediately give rise to an increased mocoilliary transport and airway resistance mediated by vagus. It can cause conjunctivitis epithelial hyperplasia of cornea, as well as eczematous inflammation of eyelids. In the form of graphite, it can cause a dust irritation, particularly to the eyes. Some forms of carbon dust can cause irritation to the eyes and mucous membranes. The human lethal oral dose is greater than 15 g/kg or more than 1 quart (2.2 lb) for 70 kg person (150 lb) (USNLM, 2003). The PEL is 15 mg/m^3 (total 5 mg/resp) (OSHA TWA). It is not listed as a known carcinogen by NTP, OSHA, or NIOSH (U.S Department of Health and Human Services, 2002).

Cetyltrimethyl ammonium bromide [CAS 57-09-0]

General Information. Cetyltrimethyl ammonium is a colorless material. Its solubility is 0.1 M in water (20 °C). It is used as a surfactant and in the detection of DNA material.

Environmental Fate and Hazards. Hazardous decomposition products are carbon monoxide, carbon dioxide, nitrogen oxides, and hydrogen bromide gas. To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated. Acute oral LD_{50} for a rat was 410 mg/kg. The acute LD_{50} for a mouse (intraperitoneal) was 106 mg/kg with various effects such as convulsions and seizures.

Other effects also result in some minor damage to the lungs, thorax, and respiratory depression.

Human Hazards. Exposure to cetyltrimethyl ammonium bromide can cause skin irritation. If inhaled, cetyltrimethyl ammonium bromide is irritating to mucous membranes and upper respiratory tract. It may be harmful if swallowed. It is not a carcinogen and no OEL has been established (U.S Department of Health and Human Services, 2002).

Cetyltrimethylammonium chloride [CAS 112-02-7]

General Information Trimethylhexadecylammonium chloride's production and use as a coagulant (antibiotic production), conditioning agent (hair products), antistatic agent (textile spin finishes), and softening agent (textile finishes) may result in its release to the environment through various waste streams.

Environemental Fate and Hazards: If released into the air, an estimated vapor pressure of 2.8 x 10^{-10} mm Hg (25 °C) indicates it will exist solely in the particulate phase in the ambient atmosphere. Particulate-phase trimethylhexadecylammonium chloride will be removed from the atmosphere by wet and dry deposition. If released into the soil, trimethylhexadecylammonium chloride is expected to have no mobility based upon an estimated K_{oc} of 2.2 x 10^{+5}. Volatilization from moist soil surfaces is not expected to be an important fate process. Trimethylhexadecylammonium chloride will not volatilize from dry soil surfaces based upon its estimated vapor pressure. If released into the water, trimethylhexadecylammonium chloride is expected to adsorb to suspended solids and sediment in water based upon the estimated K_{oc}. 10 to 20 ppm trimethylhexadecylammonium chloride was degraded with a half-life of 3.1 days in freshwater (20 °C) with a pH 6.9. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's estimated Henry's Law constant. An estimated BCF of 71 suggests the potential for bioconcentration in aquatic organisms is moderate.

Human Hazards. Occupational exposure to trimethylhexadecylammonium chloride may occur through dermal contact with this compound at workplaces where trimethylhexadecylammonium chloride is produced or used. The general population may be exposed due to the use of consumer products containing this compound. It is not a carcinogen and no OEL was found from the available literature (U.S Department of Health and Human Services, 2002).

Chlorine [CAS 7782-50-5]

General Information. Chlorine is green-yellow diatomic gas with a suffocating pugent irritanting odor. Its solubility in water is 310 cc/100 cc water (10 °C) and 1.46 g/100 cc water (0 °C), and is a corrosive liquid. It used in the bleaching of woodpulp. It is also used in the manufacture of carbon tetrachloride, trichloroethylene, polychloroprene (neoprene), metallic chlorides, chloroacetic acid, chlorinated hydrocarbons, polyvinyl chloride, and chlorinated lime. Other uses are seen in water treatment and fire suppression.

Environmental Fate and Hazards. The stability of free chlorine in natural water is very low, because it is a strong oxidizing agent and rapidly oxidizes inorganic compounds. It also oxidizes organic compounds, but more slowly than inorganic compounds. Chlorination studies conducted on natural and artificial seawater have shown two phases of chlorine losses in seawater: a rapid initial loss followed by a continuous loss at a sharply reduced rate. The initial loss reaches a saturation level that varies widely between natural seawater samples and appears to be related to a true organic demand. Losses continue over 10 day periods and are pronounced in seawater containing bromine. Other studies have indicated that the loss of chlorine is associated with the bromide chemical system in seawater. The fate of the lost chlorine was not determined. In the atmosphere the mean ambient air levels have been reported between 1 and 3.7 mg/m^3 (0.344 and 1.27 ppm). Atmospheric levels of approximately 0.001 ppm (2.9 µg/m^3) have been measured from coastal areas, and ambient levels in metropolitan areas such as Cincinnati or Baltimore average 0.02 ppm (58.0 µg/m^3). Chlorine is highly toxic to all forms of aquatic life. There is no potential for bioaccumulation or bioconcentration.

Human Hazard. Exposures most commonly result from either storage or transportation accidents involving the pressurized liquid form. Other poisonings occur in industrial accidents, school chemistry experiments, accidental release of chlorine from swimming pool operations, and mixing of cleaning agents (adding acidic cleaning agents to hypochlorite bleach releases chlorine gases). Exposure can occur through dermal contact from handling chlorine or its products in home and industry; inhalation from ambient air and workspace exposure and ingestion of food and water treated with chlorine. Chlorine is not classifiable as a human carcinogen. The PEL for chlorine is 1 ppm (3 mg/m^3) with an 8 hour TWA of 0.5 ppm (NIOSH, 2003).

Chlorine Pentafluoride (ClF_5) [CAS 13637-63-3]

General Information. Chlorine pentafluoride is a colorless gas that gives off a pungent odor and gives off white fumes in moist air. It hydrolyzes in water, and gas/vapor is

heavier than air. It is primarily used as a fluorinating agent and in pulp leaching. It is found to be corrosive and reactive.

Environmental Fate and Hazard. Adsorption of excessive F- can result in acute system fluorsis with hypocalcemia interference in various metabolic functions and organs. At times it has been found to react violently with alkalis, and violently oxidizes organic material (Air Liquid, 2002). It may cause change in various ecological systems.

Human Hazards. It has not been determined to be a carcinogen through current information available (New Jersey Department of Health and Senior Services, 2000). ClF_5 gas is heavier than air, it may accumulate in confined spaces, particularly at or below ground level. It is very toxic by inhalation and corrosive to eyes, respiratory system and skin. The PEL is 3 ppm over an 8-hour work shift set by OSHA and ACGIH. Recommend exposure level limit is 3 ppm over a 10-hour work shift and 6 ppm not to be exceeded during any 15-minute work period (New Jersey Department of Health and Senior Services, 2000).

Chlorine Trifluoride (ClF_3) [CAS 7790-91-2]

General Information. Chlorine trifluoride is a gas and has a sweet, pungent odor. It is insoluble in water and explodes on contact with water.

Environmental Fate and Hazard. The hazard of exposure to chlorine trifluoride in the atmosphere is at least as great as that of chlorine. Hazardous decomposition products are toxic gases and vapors, such as chlorine, fluorine, and hydrogen fluoride that may be released when chlorine trifluoride decomposes.

A LC_{50} through inhalation was 178 ppm/1 hour on mice. All rats exposed to 800 ppm died in 15 minutes, by reducing to 13 minutes they were allowed to survive for further testing. All rats exposed to 400 ppm died in 35 minutes. Two dogs and 20 rats exposed to an average concentration of 1.17 ppm chlorine trifluoride for 6hours/day, 5 day/week for 6 months exhibited signs of toxicity. Other symptoms included sneezing, salivation, and the occasional expulsion of frothy fluid from the mouth and nose, After two months of exposure, both dogs had recurrent bouts of pneumonia; however, six rats and one dog died during the course of the experiment. Severe pulmonary irritation was found among the survivors as well as the animals that died (BOC Gases, 1999a).

Human Hazards. Liquid chlorine trifluoride causes deep penetrating burns on contact with the body. The effect may be delayed and progressive, as in the case of burns by hydrogen fluoride. Chlorine trifluoride is an extremely reactive, corrosive and irritating

gas, which has been observed to cause a severe reaction in the lungs and mucous membranes. Chlorine trifluoride is toxic by all routes of exposure. Symptoms of exposure may be delayed. If eyes, skin, or mucous membranes are exposed, it can cause severe burns in seconds. If inhaled, it may lead to potentially fatal lung disorders. When ingested, such as in drinking water, can lead to mottled enamel of teeth and osteoscerosis. It is not listed as a carcinogen (United States Department of Health and Human Services, 2002). The PEL is 0.1 ppm (ceiling) (OSHA and ACGIH TWA).

Cyclohexyl mercaptan [CAS 1569-69-3]

General Information. Cyclohexyl mercaptan appearance is a clear, colorless liquid that is insoluble in water (Acros Organics, 2003).

Environmental Fate and Hazard. Two draize tests were conducted on two separate rabbits one application was on the eye at 500 mg for 24 hours resulting in a mild irritation and the other on the skin at 2 mg for 24 hours resulting in severe irritation. Cyclohexyl mercaptan is considered to be toxic to aquatic organisms resulting in possible long-term adverse effects in the aquatic environment. Hazardous decomposition products are carbon monoxide, oxides of sulphur, irritating and toxic fumes and gases, carbon dixide, hydrogen sulfide.

Human Hazard. Exposure may cause eye, skin, digestive tract and respiratory tract irritation. It may cause kidney, central nervous system, or cardiovascular system problems. Inhalation at high concentrations may cause CNS depression and asphyxiation. It is not listed as a carcinogen by OSHA, NIOSH, or ACGIH. The PEL for cyclohexyl mercaptan is 0.5 ppm (2.4 mg/m^3 15 minutes) (NIOSH, 2003).

Ethyl 2-cyanoacrylate [CAS 7085-85-0]

General Information. Ethyl 2-cyanoacrylate is a colorless gel with a sharp irritating odor and polymerizes in the presences of water.

Environmental Fate and Hazard. An estimated acute oral and dermal LD_{50} on rats was greater than 5000 mg/kg and great than 2000 mg/kg. Rapid exothermic polymerization will occur in the presence of water, amines, alkalis and alcohols.

Human Hazard. Exposure to vapors above the established exposure limit results in respiratory irritation that may lead to difficulty in breathing and tightness in the chest. Bonds skin in seconds and may cause skin irritation. Cyanoacrylates have been reported to cause allergic reaction, but due to rapid polymerization at the skin surface, an allergic

response is rare. Cyanoacrylates generate heat on solidification. In rare circumstances, a large drop will burn the skin. Cured adhesive does not present a health hazard, even if bonded to the skin. It may cause irritation to eyes and excessive tearing. It is doubtful that it will be harmful if ingested due to polymerization in the mouth making it difficult to swallow (Henkel Loctite, 2003). The PEL is 0.2 ppm TWA (ACGIH). OSHA, NIOSH, and ACGIH do not list it as a known carcinogen.

Ethyl mercaptan [CAS 75-08-1]

General Information. Ethyl mercaptan is a colorless liquid with a garlic-like odor. Its solubility is 6.76 g/L (20^{o}C) (Lewis, 1993). Ethyl mercaptan occurs in illuminating gas, natural "sour" Texas gas wells, petroleum distillates, and coal tar. It is a natural mammalian excretion product and occurs naturally in some vegetables such as cabbage. Ethyl mercaptan has been qualitatively detected in crude oil samples collected from Texas. The occurrence of small amounts of alkyl mercaptans in crude oil is believed to result from microbial action on elemental sulfur. Mercaptans are formed naturally in biological processes and exist in all living systems; the lower alkyl mercaptans, such as the propyl mercaptans, occur in manure gas from domestic animal pens. Small amounts of ethyl mercaptan are components of human breath. Microbes and natural gas have been identified as sources of ethyl mercaptan emissions to the atmosphere. Anthropogenic sources of environmental release include emissions from petroleum manufacture, waste treatment, and pulp mills (USNLM, 2002).

Environmental Fate and Hazards. The compound will evaporate readily from dry surfaces, and surface transport by volatilization to the atmosphere is expected to be an important fate process. Ethyl mercaptan may leach readily in moist soil and be highly mobile in the soil. Gas-phase ethyl mercaptan has been observed to penetrate soil and clay and possibly reach the groundwater. Gas-phase transport within soil systems may have some importance. Insufficient data are available to assess the relative importance of biodegradation. Volatilization half-lives of 2.5 and 29 hours can be estimated for a model river (1 m deep) and model pond (2 m deep). It will degrade readily in the atmosphere by the vapor-phase reaction with photochemically produced hydroxyl radicals with an estimated half-life of about 8 hr. Nighttime reaction with nitrate radicals may be more important since the estimated half-life is only 1 hr. Although ethyl mercaptan may directly photolyze in sunlight, the rate is not competitive with hydroxyl or nitrate radicals (USNLM, 2002).

Aquatic bioconcentration and adsorption to sediment are not expected to be important fate processes. Acute oral LD_{50} for a rat was 682 mg/kg. The LC_{50} for rat by inhalation

and mouse were 4420 ppm/4 hours and 2770 ppm/4 hours. The draize test was applied to the rabbit eye and skin resulting in moderate irritation at 84 mg and 100 mg/24 hours and mild irritation at 500 mg/24hours.

Human Hazards. Occupational exposure to ethyl mercaptan occurs through dermal contact (both vapor and liquid) and inhalation of vapor. The general population is exposed by inhalation and oral consumption that can lead to skin and respiratory irritation. If ingested, it may cause gastrointestinal irritation with nausea, vomiting and diarrhea. If inhaled at high concentrations, it may cause central nervous system effects characterized by nausea, headache, dizziness, unconsciousness and coma. Chronic ingestion may cause neurological symptoms. The PEL is 0.5 ppm TWA (ACGIH), 500 ppm IDIH (ACGIH), and 10 ppm ceiling (25mg/m^3 OSHA) USNLM, 2002). It is not listed as a carcinogen by NTP (U.S Department of Health and Human Services, 2002).

Fog Oil (Naphthenic Oil) [CAS 64742-52-5]

General Information. Fog oil is a clear light to dark amber liquid and is insoluble in water. It has a mild hydrocarbon odor and can burn in a fire. It is used in processing oil, a chemical carrier, and lubricant. It is used by the military as “obscurants” that create a cloud or haze that screens armed forces from view.

Environmental Fate and Hazards. The acute oral LD_{50} for the rat was greater than 30g/kg and fog oil was practically non-toxic through ingestion when tested. In another study, an estimated oral LD_{50}/LC_{50} for rat was greater than 5g/kg and was found to be non-toxic. A red-winged blackbird (*Agelaius phoeniceus*) was used as a surrogate species for the red-cockaded woodpecker, an endangered species usually found on military lands. Wild red-winged blackbirds were exposed to varying airborne concentrations of fog oil. The post-exposure response of the blackbirds was monitored for 28 days. Compared to control birds, no mortality, body weight loss, clinical signs of toxicity, or behavioral abnormalities were observed in any of the fog oil-treated birds. The distribution and severity of gross and histopathological lesions were independent of the fog oil exposures and were typical of those found in wild bird populations. Although respiratory function data were limited, no major respiratory impairment or abnormalities were observed during the exposure or the post-exposure period (Driver et al., 2002). Animals exposed to fog oil at high concentration can get “lipoid pneumonia” (US Army, Not known). A film or sheen will cause discoloration of surface water.

Human Hazards. Exposure routes are through inhalation, ingestion, and eye and skin contact. Fog oil will not produce vapors unless heated to a temperature of > 148 °C (300

°F). Prolonged eye or skin contact will cause an irritation, but if ingested in large amounts will cause nausea and vomiting. Fog oil has not been determined to be a carcinogen. The PELs are 5 ppm (ACHIH, OSHA) and 5 ppm TWA (NIOSH - Hydrocon 200 Series) (Smith, 1999).

Workers who worked for years with mineral oil mists have not had significant respiratory problems. Workers exposed to concentrations less than 10 mg/m^3 typically showed no pulmonary symptoms. In some instances, workers had increased cough, but the oils were usually not the purified oils used for fog oil. Animals exposed to very high concentrations of mineral oil mists can get "lipoid pneumonia." This condition is a coating of the lungs with oil making it difficult to breath, but this has not been seen in workers and typical work or training exposures are much lower. Oils can irritate the skin initially and can cause rash like conditions with chronic exposure. The oil used for fog oils has not been shown to cause these conditions. The oil used for fog oil does not contain additives that are known or thought to cause cancer (Fog oil, date not known).

Glycerol [CAS 56-81-5]

General Information. Glycerol is clear, colorless and odorless liquid. It is a syrupy liquid with a sweet taste that is found to be hygroscopic. It is soluble in water and alcohol (aqueous solution are neutral), but insoluble in ether, benzene, chloroform, and in fixed and volatile oils (Lewis, 1993). Glycerin is produced in large quantities synthetically and used in thousands of applications. It is used in alkyds, resins dynamite, ester gums, pharmaceuticals, perfumery, and plasticizers. Other uses have included liquors, solvents, binders for cements, lubricants, and softners (Lewis, 1993). It may be released to the environment in industrial effluent and during the use and disposal of the numerous products in which it is contained (USNLM, 2003).

Environmental Fate and Hazards. Glycerin is expected to undergo rapid biodegradation under aerobic conditions in the soil. Biodegradation under anaerobic conditions is also expected to occur. Glycerin will display very high mobility in soil and is not expected to significantly volatilize from either moist or dry soil to the atmosphere. Estimated soil adsorption coefficients indicated that adsorption to sediment and suspended organic matter will not be important. If released into the water, glycerin is expected to rapidly degrade under aerobic conditions. Degradation is also likely in seawater and under anaerobic conditions. Volatilization of glycerin from water will be slower then for water itself. In the atmosphere, glycerin may undergo a gas-phase oxidation with photochemically produced hydroxyl radicals resulting to a half-life of 33 hours. The

water solubility of glycerin indicates that it may also undergo atmospheric removal by wet deposition processes.

Bioconcentration factors for glycerin can be estimated at 3 and 0.2, respectively, using regression-derived equations. The magnitude of these values indicates that bioconcentration in fish and aquatic organisms are not likely to occur to a significant extent. An LC_{50} (96 hour) rainbow trout was 50 to 67 mg/L and an LC_{50} (96 hours) for goldfish was greater than 5000 mg/L. Acute oral LD_{50} for the rat, mouse, and rabbit were 12600 mg/kg, 4090 mg/kg, and 27 mg/kg, respectively. The draize test was applied to the eye and skin of a rabbit resulting in 500 mg/24 hour and 500 mg/24 hour with mild symptoms (Fisher, 2003b). Full strength glycerin causes an inflammatory reaction and edema of the cornea with wrinkling of the posterior surface and damage of endothelial cells in rabbit eyes (USNLM, 2003).

Human Hazards. Occupational exposure to glycerin may occur by dermal contact during its production, formulation, and use. Exposure to the general population may occur by dermal contact or ingestion due to the wide variety of food and personnel care products in which it is contained. OSHA, NIOSH, and ACGIH do not list it as carcinogen. Routes of exposure are by eye and dermal contact causing irritation. Ingestion of large amounts may cause gastrointestinal irritation and may cause headache. Inhalation of a mist of this material may cause respiratory tract irritation. It presents a low hazard for usual industrial handling. The PELs are 10 mg/m^3 TWA (ACGIH) and 15 mg/m^3 as total dust; 5 mg/m^3 TWA (total dust), and 5 mg/m3 TWA (respirable fraction) (OSHA).

Hexachlorobenzene [CAS 118-74-1]

General Information. Hexachlorobenzene is not a naturally occurring compound. It is a white crystalline solid that is slightly soluble in water and soluble in acetone (Lewis, 1993). It is formed as a by-product during the manufacture of chemicals such as solvents, other chlorine-containing compounds, and pesticides. Small amounts of hexachlorobenzene can also be produced during the combustion processes such as burning of city wastes. It may also be produced as a by-product in waste streams of chlor-alkali and wood preserving plants. Hexachlorobenzene was widely used as a pesticide until 1965. It was also used to make fireworks, ammunition, and synthetic rubber. Currently, the substance is not used commercially in the United States (USNLM, 2003).

Environmental Fate and Hazards. Hexachlorobenzene is expected to be immobile in the soil. Volatilization of hexachlorobenzene is expected from moist soil and water

surfaces, but adsorption may attenuate this process. Volatilization of hexachlorobenzene from dry soil surfaces is not expected based on its vapor pressure. Hexachlorobenzene is not expected to biodegrade significantly based on a measured half-life in soil of over 1,500 days. In aquatic sediment, hexachlorobenzene is expected to adsorb to suspended solids and sediment in water. Estimated volatilizations half-lives for a model river and model lake are 7 and 180 hours, when adsorption is ignored. When adsorption is considered the half-life for a model pond (2 m deep) is approximately 5 years. Hexachlorobenzene is not expected to undergo significant biodegradation based on an aerobic biodegradation half-life of about 2.6 years and an anaerobic biodegradation half-life of about 10 years in fresh waters. Based on a model of gas/particle partitioning of semivolatile organic compounds in the atmosphere, hexachlorobenzene is expected to exist in both the vapor and particulate phases in the ambient atmosphere. Vapor-phase hexachlorobenzene is degraded in the atmosphere by reaction with photochemically produced hydroxyl radicals equaling an estimated half-life of 2.6 years. Particulate-phase hexachlorobenzene may be physically removed from the air by wet and dry deposition.

BCF values in the range of 1,600 to 20,000, measured in fish, suggest that bioconcentration in aquatic organisms is very high. BCF values of 2,700 to 4,800 were measured in carp (*Cyprinus carpio*) exposed to 10 µg/l of hexachlorobenzene during an 8-week incubation period and BCF values of 1,600 to 3,900 were measured in carp exposed to 1 µg/l of hexachlorobenzene during an 8-week incubation period. Log BCF values in trout were given as 3.7 to 4.3, and in sunfish log BCF values of 3.1-4.3 were reported. According to a classification scheme, these BCF values suggest that bioconcentration in aquatic organisms is very high. Larval stages of midge (*Chironmus decorus)* were used to define the bioaccumulation of sediment sorbed mono-, di-, tri-, and hexachlorobenzenes. Larvae were exposed to high and low organic content sediments equilibrated with individual radiolabeled chlorobenzenes prior to testing. The uptake of chlorobenzenes by midge larvae was rapid for all compounds, and apparent steady state conditions were reached within 48 hr. of exposure. BCF for the accumulation of chlorobenzenes from sediments and from interstitial and overlying waters were related to the octanol/water partition coefficients of the compound. Bioaccumulation was dependent on the concentration of the chemicals in interstitial water.

Hexachlorobenzene was detected at concentrations of 1 to 5 ng/g in leaves and lichens from various trees in Italy. Hexachlorobenzene was detected at concentrations of 0.4 to 1.8 ng/g (dry weight) in lichen from Ontario, Canada between 1985 and 1987. Hexachlorobenzene was detected at concentrations of 4 to 5,700 ng/g in tree bark worldwide and at concentrations of 0.2 to 3.4 ng/g in pine needles in the vicinity of a

metal reclamation facility in Finland. Hexachlorobenzene was detected at concentrations of 0.05 to 2.40 ng/g in pine needles collected from Germany, Denmark, Norway and Sweden. Hexachlorobenzene was detected at a median concentration of 0.02 ng/g in mango leaves from Africa (USNLM, 2003).

Human Hazards. Based on representative levels of hexachlorobenzene in air, water, and food, the total intake of it by adults in the general population is predominantly from the diet. It is listed as a possible carcinogen. The PEL for hexachlorobenzene is 0.002 mg/m^3 (skin 8 hr TWA) (USNLM, 2003). It is readily absorbed by the oral route in experimental animals and poorly via the skin. In animals and humans, it accumulates in lipid-rich tissues, such as adipose tissue, adrenal cortex, bone marrow, skin and some endocrine tissues, and can be transferred to offspring both across the placenta and via mothers' milk. It undergoes limited metabolism, yielding pentachlorophenol, tetrachlorohydroquinone and pentachlorothiophenol as the major metabolites in urine. The few available epidemiological studies of cancer are insufficient to assess the carcinogenicity of hexachlorobenzene to humans. There are few experimental studies on which an environmental risk assessment can be made. However, its hexachlorobenzene concentrations suggest that hexachlorobenzene has the potential to harm embryos of sensitive bird species and to cause adverse effects in fish-eating mammals.

Isopropyl mercaptan [CAS 75-33-2]

General Information. Isopropyl mercaptan is a clear liquid and has an extremely unpleasant odor. It is slightly soluble in water (Lewis, 1993). Isopropyl mercaptan occurs naturally in manure gas from domestic animal pens and in various crude oils and is formed naturally by biological processes. Isopropyl mercaptan's use as an odorant additive for natural gas can result in its release to the atmosphere in fugitive emissions and major leaks of commercially supplied natural gas. Isopropyl mercaptan has been qualitatively detected in crude oil samples collected from Texas. The occurrence of small amounts of alkyl mercaptans in crude oil is believed to result from microbial action on elemental sulfur (USNLM, 2003).

Environmental Fate and Hazards. Isopropyl mercaptan's relatively high vapor pressure suggests that the compound will evaporate readily from dry surfaces. Therefore, surface transport (by volatilization) to the atmosphere is expected to be an important fate process. Isopropyl mercaptan may leach in moist soil. Isopropyl mercaptan is moderately to highly mobile in soil. Gas-phase isopropyl mercaptan has been observed to penetrate soil and clay, therefore gas-phase transport within soil systems may have some importance. Insufficient data are available to assess the relative importance of biodegradation in soil

and water. Volatilization is expected to be an important transport processes for isopropyl mercaptan in water with half-lives of 2.7 and 32 hours can be estimated from a model river (1 m deep) and model pond (2 m deep). Aquatic bioconcentration and adsorption to sediment are not expected to be important fate processes. Isopropyl mercaptan is expected to exist primarily in the vapor-phase in the ambient atmosphere and will degrade readily in the atmosphere by the vapor-phase reaction with photochemically produced hydroxyl radicals with an estimated half-life of about 9 hours.

An estimated BCF of 8 suggests that bioconcentration in aquatic organisms is not environmentally important. A LC_{50} done on mice by inhalation was 130mg/m^3/1 hour (Acros Organics, 2003a).

Human Hazards. Occupational exposure to isopropyl mercaptan occurs through dermal contact (both vapor and liquid) and inhalation of vapor. NIOSH (NOES Survey 1981-1983) has statistically estimated that 4,715 workers are potentially exposed to isopropyl mercaptan in the USA (USNLM, 2003). Strong odor can cause headaches, nausea, and at high concentrations can produce unconsciousness with cyanosis. It may cause skin and eye irritation. It is not listed as a carcinogen from the available information (United States Department of Health and Human Services, 2002). The OEL has not been established from the available information.

Magnesium Oxide [CAS 1309-48-4]

General Information. Magnesium oxide is a white powder, either light or heavy, depending upon whether it is prepared by heating magnesium carbonate or the basic magnesium carbonate. It is soluble in acids and ammonium salt solutions; however it is insoluble in water (Mallinckrodt Baker, Inc, 2003; Lewis, 1993). Two forms are produced, one light fluffy material prepared by a relatively low temperature dehydration of the hydroxide. The other is a dense material made by high temperature furnacing of the oxide, after it has been formed from the carbonate or hydroxide (Lewis, 1993). Magnesium oxide is also used as feed supplementary in the manufacture of poultry and cattle feed to replenish the lose of magnesium in cattle due to milking.

Environmental Fate and Hazards. The fate in air for magnesium oxide is a dense powder and when released into air it will quickly settle to the ground. It does not travel to the upper atmosphere. It is not an ozone depleting substance. Because of its high melting and boiling points, it is not transported as vapor or fumes in air.

The fate in soil and water is relatively inert, although it persists in the environment. No adverse effects have been documented. Magnesium oxide is insoluble in water and it is

not transported by ground water. The oxide forms magnesium hydroxide under alkaline conditions and is transported by water. This compound is soluble in water under acidic conditions and can be transported by acidic ground water. No information on its ecological effects is available.

The acute oral LD_{50} for unknown organism was 810 mg/kg. Tumorigenic effects have been observed on tests with laboratory animals.

Human Hazards. It is a non-combustible compound. Inhalation may cause irritation to the nasal passages, respiratory tract resulting in a flu-like illness (metal fume fever). Symptoms accompaning fevers are chills, aching muscles, dryness in the mouth and throat, and headache. The PEL is 15 mg/m^3 (OSHA) and 10 mg/m^3 (ACGIH). It is not known if magnesium oxide is a carcinogen (Sanders, 2003; (United States Department of Health and Human Services, 2002).

Mercaptoacetic Acid [CAS 68-11-1]

General Information. Mercaptoacetic acid is a colorless liquid with a strong unpleasant odor. It is miscible in water, alcohol, and ether. Mercaptoacetic acid is produced and used as an ingredient in permanent hair wave solutions and depilatories, as a chelating agent, chemical intermediate, vinyl stabilizer, and in the manufacture of pharmaceuticals (Lewis, 1993)

Environmental Fate and Hazards. Its vapor pressure indicates mercaptoacetic acid will exist solely as a vapor in the ambient atmosphere. Vapor-phase mercaptoacetic acid will be degraded in the atmosphere by reaction with photochemically produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 10 hours. If released in the soil, mercaptoacetic acid is expected to have very high mobility based upon an estimated K_{oc} of 27. Volatilization from moist soil surfaces is not expected to be an important fate process. The pKa of mercaptoacetic acid is 3.6 indicating that this compound will exist in the dissociated form in the environment and anions generally do not adsorb to organic carbon and clay more strongly than their neutral counterparts. Mercaptoacetic acid is expected to biodegrade in soil based upon numerous aqueous biodegradation tests, although acclimation may be important. If released into water, mercaptoacetic acid is not expected to adsorb to suspended solids and sediment in water based upon the estimated K_{oc}. Mercaptoacetic acid is expected to biodegrade in aquatic systems although acclimation may be important, based on numerous aqueous aerobic biodegradation tests that used soil or activated sludge inoculum. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's estimated Henry's

Law constant. Furthermore, a pKa of 3.8 indicates mercaptoacetic acid will exist almost entirely in the ionized form at pH values of 5 to 9 and anions are not expected to volatilize from water surfaces.

An estimated BCF of 0.69 suggests that the potential for bioconcentration in aquatic organisms is low. Acute oral LD_{50} for the rat, mouse, rabbit, and guinea pig was 114 mg/kg, 242 mg/kg, 119 mg/kg and 126 mg/kg, respectively. Acute intravenous LD_{50} for rabbit and mouse was 100 and 145 mg/kg. Fatalities were produced by application of a 10% solution to guinea pigs skin at less than 5 ml/kg with associated symptoms as weakness, gasping respirations and convulsions, while the same was observed in rats (USNLM, 2003).

Human Hazards. Occupational exposure to mercaptoacetic acid may occur through inhalation of aerosols or dermal contact with this compound at workplaces where it is produced or used. The general population may be exposed to mercaptoacetic acid via inhalation of aerosols or dermal contact with this compound associated with its use in hair waving solutions (USNLM, 2003). It is not listed by OSHA, ACGIH, or NIOSH as a carcinogen (Fisher Scientific, 1995). The PEL is 1 ppm (4mg/m^3) TWA [skin] (NIOSH, 2003). Exposure routes are inhalation, eye and skin absorption, and ingestion. When exposed to skin, it has been known to cause lesions and burns to skin. If inhaled at high concentration can produce unconsciousness with cyanosis, cold extremities, and rapid pulse (Lewis, 1993).

2-Mercaptoethanol [CAS 60-24-2]

General Information. 2-Mercaptoethanol is a water-white, mobile liquid with a disagreeable odor. It is miscible in water and in most organic solvents. It is used as a solvent for dyestuff, rubber chemicals, flotation agents, insecticides, plasticizer, water-soluble reducing agent and PVC stabilizers (Lewis, 1993). 2-Mercaptoethanol is formed through the decomposition of naturally occurring products such as swine manure and proteins (produced by marine algae and other marine plants). Human sources of releases may include solvent evaporation (USNLM, 2003).

Environmental Fate and Hazards. 2-mercaptoethanol may leach readily in the soil. Though the results of one soil degradation study indicate that 2-mercaptoethanol is biodegradable, insufficient data are available to predict the relative importance or rate of microbial degradation in soil and possibly water. 2-mercaptoethanol has very high soil mobility and will leach in soils (USNLM, 2003). Aquatic volatilization, bio-concentration, and adsorption to sediment are not expected to be important environmental

processes. The reaction between hydroxyl radicals and 2-mercaptoethanol in brightly sunlit natural water at a set concentration is estimated to have a half-life of 118 days. 2-mercaptoethanol is expected to exist almost entirely in the vapor phase in the ambient atmosphere. It will degrade relatively rapidly in an average ambient atmosphere by reaction with photochemically produced hydroxyl radicals (estimated half-life of 8.7 hr). Since 2-mercaptoethanol is miscible in water, physical removal from air via wet deposition is likely to occur (USNLM, 2003).

A estimated BCF of 0.3 suggests that 2-mercaptoethanol will not bioconcentrate significantly in aquatic organisms. 2-mercaptoethanol is miscible in water, which also suggests that it will not biconcentrate in aquatic organisms. Acute oral LD_{50} for rat was 244 mg/kg, and when applied to a rabbit's skin the LD_{50} was 150 mg/kg. It is an eye irritant in rabbits and is being investigated as a mutagen.

Human Hazards. Occupational exposure to 2-mercaptoethanol may occur through inhalation of vapor and dermal contact. It is found to be toxic when inhaled or ingested (Lewis, 1993). It causes severe eye, respiratory and digestive tract irritation. The target organs are the central nervous system, respiratory system, and eyes. If ingested, it may cause gastrointestinal irritation with nausea, vomiting and diarrhea. It causes muscle paralysis, respiratory failure, and possible death. When inhaled at high concentrations, it may cause central nervous system effects characterized by nausea, headache, dizziness, unconsciousness, dyspnea (difficult or labored breathing), and coma. Exposure to high concentrations of mercaptans can produce unconsciousness with cyanosis (bluish discoloration of skin due to deficient oxygenation of the blood), cold extremities, and rapid pulse. Mercaptans are known to cause nausea and headache at times.

3-Mercaptopropionic acid [CAS 107-96-0]

General Information. 3-Mercaptopropionic acid is a clear liquid and soluble in water and alcohol. It is used as a stabilizer, antioxidant, catalyst, and chemical intermediate (Lewis, 1993).

Environmental Fate and Hazards. Hazardous decomposition products are carbon monoxide, oxides of sulfur, carbon dioxide (3-Mercaptopropionic acid, 2003). Acute oral LD_{50} for rat was 96 mg/kg. One study found that 3-Mercaptopropionic acid caused weakness and convulsion and death in rats after 30-minutes into the treatment. A low application was given to guinea pigs through the skin causing their deaths at 5 mL/kg (USNLM, 2002).

Human Hazards. It is an eye and skin irritant and causes burns to both. When ingested, it causes gastrointestinal tract burns and may cause perforation of the digestive tract. If inhaled, it may cause irritation of the respiratory tract with burning pain in the nose and throat, coughing, wheezing, shortness of breath and pulmonary edema and causes chemical burns to the respiratory tract. It is not listed as a carcinogen by OSHA or NTP (Acros Organics, 2003d). No OEL was found in the available literature.

3-Methyl indole [CAS 83-34-1]

General Information. 3-Methyl indole is a naturally occurring substance found in beetroot, feces, and nectrandra wood. It is a white, crystalline substance and browns upon aging. It is soluble in hot water, alcohol, and benzene. When mixed with potassium ferrocyanide and sulfuric acid it results in a violet color. (Lewis, 1993) It is more commonly known as skatole (Lewis, 1993). It is also produced industrially for use as a fixative in the perfume industry and as a food additive (USNLM, 2003).

Environmental Fate and Hazards. A methanogenic consortium, enriched from wetland soil completely mineralized 13 mg of 3-methylindole within 35 days. 3-Methylindole will have low mobility in soil and volatilization may occur slowly from moist soil surfaces. Based on its K_{oc} value, 3-methylindole is expected to adsorb to suspended solids and sediment in water. 3-Methylindole will volatilize from water surfaces and has estimated half-lives for a model river and model lake are 20 and 148 days, respectively. When exposed to natural sunlight 3-methylindole may undergo photo-oxidative degradation. A model study of gas/particle partitioning of semi-volatile organic compounds determined that in the atmosphere, it will exist primarily as a vapor. In vapor phase, it is degraded in the atmosphere photochemically resulting in a half-life of about 0.64 hours. When exposed to natural sunlight the aqueous rate constant for the photolysis of 3-methylindole was 0.18 hour with a half-life of 3.8 hours (USNLM, 2003).

An estimated BCF value of 56 suggests that bio-concentration in aquatic organisms is moderate. One study showed that when an oral dose was administered to a frog, 1g/kg was the minimum lethal dose causing paralytic action to the central nervous system. An oral dose of 0.3g/kg was given to goats and produced pulmonary edema that resulted in death. The acute oral LD_{50} for rats was 3450 mg/kg.

Human Hazards. 3-Methyl indole is not listed as a carcinogen by OSHA or ACGIH. It is an eye and skin irritation. If ingested or inhaled may cause irritation to the respiratory or digestive tract. The toxicological properties of this substance have not been fully investigated. The OEL has not been established for 3-methyl indole (Acros Orgranics,

2001). It is not a known carcinogen (U.S Department of Health and Human Services, 2002).

Methyl mercaptan [CAS 74-93-1]

General Information. Methyl mercaptan is a water-white liquid, or colorless gas with an unpleasant odor. It is slightly soluble in water, but soluble in alcohol, ether, and petroleum naphtha (Lewis, 1993). Methyl mercaptan is produced and used in chemical synthesis and as an odorant in natural gas. Methyl mercaptan is also generated in salt marshes, soils, freshwater algae, and decomposing algal mats. A major source of methyl mercaptan is the microbial degradation of methionine.

Environmental Fate and Hazards. If released in the air, gas-phase methyl mercaptan will be degraded in the atmosphere by reaction with photochemically produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 11.7 hours. In the nighttime, methyl mercaptan will react with nitrate radicals. Under photochemical smog conditions, the half-life is 2 hr. If released in the soil, methyl mercaptan is expected to have high mobility. Gaseous methyl mercaptan adsorbs to dry and moist soil surfaces. Volatilization from moist soil surfaces is expected to be an important fate process. Methyl mercaptan may volatilize from dry soil surfaces based upon its vapor pressure. Under anaerobic conditions in soils, dimerization of methyl mercaptan to dimethyl disulfide will occur. If released in the water, methyl mercaptan is not expected to adsorb to suspended solids and sediment. Methyl mercaptan is produced under anaerobic conditions (e.g. in salt marshes) by sulfate-reducing and methane-producing bacteria from methionine, or reversibly formed from dimethyl sulfide. Ultimately, methyl mercaptan may be mineralized to methane, carbon dioxide, and hydrogen sulfide. When incubated in anaerobic lake sediment for 4 hours, methyl mercaptan was rapidly mineralized. Volatilization from water surfaces is expected to be an important fate process. Estimated volatilization half-lives for a model river and lake are 50 minutes and 2.8 days. Hydrolysis is not expected to be an important environmental fate process, since this compound lacks functional groups that hydrolyze under environmental conditions.

An estimated BCF of 3 suggests the potential for bioconcentration in aquatic organisms is low. Fish are highly sensitive to methyl mercaptan. The no-effect level is 0.5 ppm and the minimum lethal concentration is 0.9 ppm for the coastal cutthroat trout and king and silver salmon. Methyl mercaptan was lethal at 1 ppm to white bass (*Morone chrysops*), yellow perch (*Perca flavescens*), largemouth bass (*Micropterus salmoides*) and smallmouth bass (*Micropterus dolomieu*), bluegills, and rock bass (*Ambloplites rupestris*). King salmon (*Oncorhynchus tschawytscha*) (10 fish) were exposed for 120

hours in static cylindrical glass jugs of 18 L capacity with a Lethal Concentration $_{100}$ (LC_{100}) of 0.9 mg/L. Similar exposures resulted in LC_{100} values of 1.75 mg/L and 1.2 mg/L in the silver salmon (*Oncorhynchus kisutch*) and in coastal cutthroat trout (*Salmo clarki*) (USNLM, 2003).

Acute oral LD_{50} for rats was 114 mg/kg. Rats that inhaled methyl mercaptan at 1,400 ppm for 15 minutes became lethargic or lapsed into reversible coma. A LC_{50} of 675 ppm was reported for male and female rats exposed to methyl mercaptan for 4 hours when exposed to 700 ppm and above there was an increase of 100% morality (USNLM, 2003). At one time, it was investigated in the etiology of periodontal disease in some instances. Trace amounts of methyl mercaptan are present in the roots and leaves of some plants.

Human Hazards. Occupational exposure to methyl mercaptan may occur through inhalation and dermal contact with this compound at workplaces where methyl mercaptan is produced or used. Workers will primarily be exposed to methyl mercaptan via inhalation in work settings such as pulp mills and oil refineries or water treatment works. Monitoring data indicate that the general population may be exposed to methyl mercaptan via inhalation of ambient air and ingestion of some foods. Symptoms associated with exposure are irritation to eyes, skin, nose, throat; lacrimation (discharge of tears), corneal damage; skin burns, blisters. In animals, symptoms include lassitude (weakness, exhaustion), gasping respirations, and convulsions. The established PEL is 1 ppm (4 mg/m^3 skin) (NIOSH, 2003). The Department of Health and Human Services (DHHS), the IARC, and the EPA have not classified methyl mercaptan for carcinogenicity (ASTDR, 2004).

Persons that are at risk are those with existing liver damage, or those that may already have elevated blood levels of methyl mercaptan and thus may be at greater risk for the neurological effects of exposure to exogenous methyl mercaptan than would be persons with normal livers (ATSDR, 1992). Hemolytic response to methyl mercaptan exposure may be enhanced by the presence of inherited erythrocytic glucose-6-phosphate dehydrogenase (G-6-PD) deficiency. Although hemolysis may occur in any person who is exposed to a sufficiently high dose of methyl mercaptan, this enzyme deficiency may cause some persons to be unusually sensitive, since it results in an inability to maintain reduced glutathione that is needed for the integrity of the erythrocyte membrane. There is a higher incidence among certain groups of Asians and Mediterranean’s (Italians, Sardinians, Greeks), and Middle Eastern populations. A study of hemolytic anemia in American black children with G-6-PD deficiency suggests that this is another population that may be susceptible to the hemolytic effects of methyl mercaptan exposure (Shannon and Buchanan, 1982).

1-Methyl-1-propanethiol [CAS 513-53-1]

General Information. 1-Methyl-1-propanethiol is a colorless, clear liquid with an unpleasant odor (Lewis, 1993). It is slightly soluble in water and very soluble in alcohol ether and liquid hydrogen sulfide. It is known also as sec-butyl mercaptan and 2-butanethiol. It is used in odorants in natural and liquefied petroleum gas (USNLM, 2003).

Environmental Fate and Hazard. Sec-butyl mercaptan should have high mobility in soil. Volatilization of sec-butyl mercaptan is expected from both moist and dry soils. In water, sec-butyl mercaptan is expected to volatilize rapidly with estimated half-lives of 2.9 hours and 3.8 days from a model river and a model lake, respectively. Insufficient data are available to determine the rate or importance of biodegradation of sec-butyl mercaptan in soil or aquatic conditions. Sec-butyl mercaptan will exist in the vapor phase in the ambient atmosphere. If released to the atmosphere, it will degrade by reaction with photochemically produced hydroxyl radicals with an experimental half-life of 9 to 10.8 hours. Removal of sec-butyl mercaptan from the atmosphere can occur though wet deposition (USNLM, 2003).

Bioconcentration and adsorption to sediment are not expected to be important fate processes in aquatic systems (USNLM, 2003).

Human Hazard. Exposure to sec-butyl mercaptan can occur through dermal contact, inhalation, and ingestion. No OEL for sec-butyl mercaptan has been established. It is irritating to the eyes, respiratory system and skin. The target organ that has been identified is central nervous system. Strong offensive smell of mercaptans will cause headache and nausea. At high concentrations, the vapors can at times produce unconsciousness with cyanosis. Other symptoms noticed were a sense of coldness at the extremities, a quickening of the pulse, and eventually pulmonary edema.

2-Methyl-2-propanethiol [CAS 75-66-1]

General Information. 2-Methyl-2-propanethiol is a colorless liquid with a strong skunk odor. It is slightly soluble in water and very toxic. It is used as an intermediate, gas odorant for detecting leaks and as a bacteria nutrient (Lewis, 1993).

Environmental Fate and Hazard. 2-Methyl-2-propanethiol will have moderate mobility in soil. One study found when natural gas containing 2-Methyl-2-propanethiol was passed through montmorillonite clay, this compound was not readily absorbed, but over 85% of the odorant appeared in the effluent gas. 2-Methyl-2-propanethiol may volatilize from dry and moist soil surfaces. There was not evidence to determine the biodegradability of 2-Methyl-2-propanethiol.Volatilization half-lives of 2.9 hours and 3.8

days have been estimated for a model river and a model lake, respectively. 2-Methyl-2-propanethiol should not absorb strongly to sediment and particulate matter in the water column. 2-Methyl-2-propanethiol exists in the vapor phase and is expected to degrade rapidly in this vapor phase by reaction with photochemically produced hydroxyl radicals with half-lives ranging from 11.0 to 13.3 hours as determined from experimental rate constants (USNLM, 2003).

2-Methyl-2-propanethiol has an estimated BCF of 25 and is not expected to bio-concentrate in aquatic organisms. The acute oral LD_{50} for rats was 4729 mg/kg and through inhalation it was 22,000 ppm/48 hours. And the LD_{50} by inhalation on the mouse was 16,500 ppm/4 hours. One study on rats found that at 9 ppm inflamed lesions on the lungs appeared, at 97 ppm mild interstitial fibrosis, and at 196 ppm interstitial fibrosis in the lungs of males and females, and nephrosis in male rats only was indicated (USNLM, 2003).

Human Hazards. Routes of exposure are through ingestion, inhalation, dermal contact, and eye contact. It may cause eye and skin irritation. Ingestiion may cause gastrointestinal irritation with nausea, vomiting and diarrhea. Mercaptans may cause nausea and headache. Exposure to high concentrations of mercaptans can produce unconsciousness with cyanosis, cold extremities and rapid pulse. If inhaled vapors may cause dizziness or suffocation. Prolong exposure causes cyanosis, acidosis, and quick, shallow breathing (2-Acros Organics, 2003c). There is no established OEL for 2-Methyl-2-propanethiol. It is found to be a toxic chemical by the EPA and not a known carcinogen (U.S Department of Health and Human Services, 2002).

Methyltrioctadecylammonium bromide [CAS 18262-86-7]

General Information. Methyltrioctadecylammonium bromide is a powder that has a faint beige color.

Environmental Fate and Hazards. Hazardous decomposition products are carbon monoxide, carbon dioxide, nitrogen oxides, and hydrogen bromide gas. There is little information on the environmental fate of methyltrioctadecylammonium bromide.

Human Hazard. Methyltrioctadecylammonium bromide is a skin and eye irritant. When inhaled, it is irritating to the mucous membranes and upper respiratory tract. No OEL was found for this material. It is not a known carcinogen (U.S Department of Health and Human Services, 2002).

Methyltrioctylammonium bromide [CAS 35675-80-0]

General Information. Methltrioctylammonium bromide appears is a light-yellow paste.

Environmental Fate and Hazard. Hazardous decomposition products are carbon monoxide, carbon dioxide, nitrogen oxides, and hydrogen bromide gas. There is little information on the environmental fate of methltrioctylammonium bromide.

Human Hazards. Routes of exposure are through inhalation, ingestion, or through skin adsorption. The material is irritating to mucous membranes and upper respiratory tract when inhaled. It causes eye and skin irritation. No OEL was found for this material. It is not a known carcinogen (U.S Department of Health and Human Services, 2002).

Methyltrioctylammonium chloride [CAS 63393-96-4]

General Information. Methyltrioctylammonium chloride is found to be in a liquid form.

Environmental Fate and Hazards. Hazardous decomposition products are carbon monoxide, carbon dioxide, nitrogen oxides, and hydrogen chloride gas. Hazardous polymerization will not occur. It is toxic to aquatic systems. In tests with *Daphnia magna* EC_{50} values were 0.01 - 0.040 mg/l (48 hours), while in the rainbow trout (Onchorhynchus mykiss) the LC_{50} values were 0.18 - 0.320 mg/L (96 hours).

Human Hazards. It causes skin, eye and respiratory irritation. When inhaled, material is irritating to mucous membranes and upper respiratory tract. When ingested, symptoms of exposure may include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea, and vomiting. To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated. No OEL was found for this material. It is not a known carcinogen (U.S Department of Health and Human Services, 2002).

1-Octanethiol [CAS 111-88-6]

General Information. 1-Octanethiol is a clear liquid, and with a mild odor. It is insoluble in water.

Environmental Fate and Hazards. 1-Octanethiol's production and subsequent use as a polymerization conditioner and in synthesis may result in its release to the environment through various waste streams. In the atmosphere, 1-octanethiol will exist predominantly in the vapor-phase and will react rapidly with hydroxyl radicals with an estimated half-life of 8 hours. 1-octanethiol should have only slight mobility in soil and is expected to volatilize from moist and dry soil surfaces. 1-Octanethiol will volatilize quickly from

water surfaces; the volatilization half-life from a model river was calculated as 3.5 hours and from a model lake as 4.8 days, respectively. Adsorption to particulate and organic matter in the water column may also be a major fate process for this compound given its K_{oc} value. Insufficient data are available to determine it's biodegradability in soil or water, but its linear alkyl chemical structure would suggest that biodegradation would be important (USNLM, 2003).

A BCF value of 930 suggests that 1-octanethiol may bioconcentrate in aquatic organisms. Acute oral LD_{50} and LC_{50} for a rat was 2000 mg/kg and greater than 0.24 mg/L/4 hours. The LD_{50} when applied to rabbit's skin was greater than 2000 mg/kg (1-octanethiol).

Human Hazards. The recommend exposure level (REL) by NIOSH REL is 0.5 ppm (3.0 mg/m^3) [15-minute] (NIOSH, 2003). It was not found to be a known carcinogen (U.S Department of Health and Human Services, 2002). It may cause eye and skin irritation. If inhaled, it may cause respiratory and digestive tract irritation. It has been found to cause headache, blurred vision, lethargy, irritability and unconsciousness at high concentrations when inhaled. If ingested, it can possibly cause labored breathing, sedation, and muscle weakness. If swallowed, may be aspirated resulting in inflammation and possible fluid accumulation in the lungs (Chevron Phillips, 2001).

2,2'-Oxydiethanethiol (2-mercaptoethyl ether) [CAS 2150-02-9]

General Information. 2-mercaptoethyl ether is a colorless to faint yellow liquid.

Environmental Fate and Hazards. Hazardous decomposition products are carbon monoxide, carbon dioxide, sulphur oxides, and hydrogen sulfide gas. Modes and products of 2-mercaptoethyl ether degradation in soil, water, and air were not available.

Human Hazards. Exposure effects may be harmful by inhalation, ingestion, or skin absorption. It is an eye and skin irritant, and irritating to the mucous membranes and upper respiratory tract. Symptoms associated with exposure are nausea, headache, and vomiting. An OEL has not been established. It is not known whether it is a carcinogen to either animals or humans (Sigma-Aldrich, 2002).

Polyethylene glycol [CAS 25322-68-3]

General Information. Polyethylene glycol ranges in appearance from a clear, colorless, and viscous liquid to waxy solids. It is soluble with water, alcohol, and other organic solvents. It is heat-stable, and inert to many chemical agents. It will not hydrolyze or

detoriate and is combustible. It is used as a chemical intermediate, plasticizer, and in ointments, paper coating, metal and rubber processing (Lewis, 1993).

Environmental Fate and Hazards. Acute oral LD_{50} for the rat was greater than 5000 mg/kg. Mild irritation effect was found on rabbit skin at 500 mg/24 hours and on eyes at 500 mg/24 hours. Hazardous decomposition products are carbon dioxide and carbon monoxide that may form when heated to decomposition (Sigma-Aldrich, 2002d).

Human Hazards. Polyethylene glycol is not considered a health hazard, based on previous occupational exposures. There was no evidence found other than topical irritation from a base solution (50%) when polyethylene glycol 400 was used on human eyes in an aqueous solution for decontamination after an accident with phenol. It was found that a 1:1 solution caused a slight burning sensation and a 1:2 was completely non-irritating when used to flush the surface of the eye (USNLM, 2003). The workplace environmental exposure level for 8-hour TWA is 10 mg/m^3 (as an aerosol) (Mallinckrodt, 2001). Polyethylene glycol is not listed as a carcinogen and is presently being used as a therapy drug for cancers such as colon cancer (U.S Department of Health and Human Services, 2002; Yuying et al., 1997).

Terephthalic Acid [CAS 100-21-0]

General Information. Terephthalic acid appears as white crystals or powder. It is insoluble in water, chloroform, ether, and acetic acid. It is slightly soluble in alcohol and soluble in alkalies, and is combustible. It is used in the production of linear, crystalline polyester resins, fibers, films, and as an additive to poultry feeds (Lewis, 1993). It is the 23rd highest volume chemical produced in the United States.

Environmental Fate and Hazards. Terephthalic acid is likely to enter the environment during production and use in the manufacture of polyester fibers, films, and bottles. If released to soil, terephthalic acid will be lost primarily by biodegradation. The mobility of terephthalic acid in soil is expected to be moderate. If released to water, terephthalic acid may biodegrade. Hydrolysis and photolysis do not appear to be important fate processes in water. The volatilization of the dissociated and undissociated acid from water will not be important and in most waters terephthalic acid will be found in the dissociated form. If released in the air, vapor-phase terephthalic acid may react with photochemically-produced hydroxyl radicals with an estimated half-life of 58 days. Particulate terephthalic acid may be removed from the atmosphere by both wet and dry deposition. Due to its persistence in the atmosphere, terephthalic acid may travel long

distances in air. Terephthalic acid has been detected in the ambient air in urban and remote areas, surface water and in certain industrial effluents (USNLM, 2003).

The acute oral LD_{50} for mouse was greater than 5000 mg/kg and the acute dermal LD_{50} for rabbit was greater than 2000 mg/kg. Mild irritation was observed in rabbits following administration of terephthalic acid in a standard draize test. In another test, no eye damage was observed in rabbits following application of 50 mg terephthalic acid. Application of 0.2 mL of solution of terephthalic acid in water did not produce irritation in rats and was not absorbed through the skin. No harmful effects have been observed in rats following inhalation of very high concentrations (up to 400 mg/m^3) terephthalic acid dust for 30 minutes. Reduced weight gain was observed in rats exposed to 25 mg/m^3 for 4 weeks.

Bladder and urinary tract cancers have been observed in rats in two studies following ingestion of high dietary concentrations of terephthalic acid for 2 years. After reviewing these studies and other toxicity data, it was concluded that the carcinogenic effect is secondary to the development of bladder stones. The dose level was high and not relevant to occupational exposures. Terephthalic acid has caused effects, but only in the presence of maternal toxicity. No teratogenic effects were observed in offspring following exposure of rats to 1, 5, or 10 mg/m3 terephthalic acid during pregnancy (CHEMINFO, 2004).

Based on the K_{oc} value, the bioconcentration of terephthalic acid in aquatic organisms should not be important.

Human Hazards. The probable routes of worker's exposure to terephthalic acid during its manufacture and use as a chemical intermediate are inhalation and dermal. Terephthalic acid is low in acute oral toxicity, based on animal information. Bladder stones have been observed in animal studies following long-term ingestion of high dietary concentrations. Based on these animal studies, it was concluded that bladder stones could occur if humans absorbed at least 2000 mg/day of terephthalic acid. At high concentrations symptoms may include coughing and mild, temporary irritation. NTP has not listed this chemical as a carcinogen. Terephthalic acid did not cause teratogenic effects, except in the presence of maternal toxicity, in three animal studies. Terephthalic acid was observed not to accumulate in the body of a rat after a 24 hours observation (CHEMINFO, 2004). The PEL for terephthalic acid is 10 mg/m^3 TWA (ACGIH) (Acros Organics, 2003).

Discussion. It can burn strongly when heated. It is combustible dust and may form explosive dust-air mixtures. It is essentially non-toxic following short-term exposure.

Tetraoctylammonium bromide [CAS 14866-33-2]

General Information. Tetraoctylammonium bromide appears as fine white crystals.

Environmental Fate and Hazards. Materials to avoid are strong oxidizing agents which can create possible noxious and lethal gases. Hazardous decomposition products are carbon monoxide, carbon dioxide, nitrogen oxides, and hydrogen bromide gas. There is little information on the environmental fate of tetraoctylammonium bromide.

Human Hazards. When inhaled, material is irritating to mucous membranes and upper respiratory tract. It may be harmful by inhalation, ingestion, or skin absorption and causes eye and skin irritation. No OEL was found for this material. It is not a known carcinogen (U.S Department of Health and Human Services, 2002).

Tetraoctylammonium chloride [CAS 3125-07-3]

General Information. Tetraoctylammonium chloride is a colorless crystal structure material. Its solubility is not known from the available literature. It is used in nano-technology such as in chemical detectors.

Environmental Fate and Hazards. Hazardous decomposition products are carbon monoxide, carbon dioxide, nitrogen oxides, ammonia, and hydrogen chloride gas. Hazardous polymerization will not occur. There is little information on the environmental fate of tetraoctylammonium chloride.

Human Hazards. It is irritating to eyes, respiratory system and skin. No OEL was found for this material. It is not a known carcinogen (U.S Department of Health and Human Services, 2002).

Thiophenol [CAS 108-98-5]

General Information. Thiophenol appears as a clear, colorless liquid with garlic like odor. Thiophenol is insoluble in water, but is soluble in alcohol benzene, and ether. Thiophenol is produced and used as a chemical intermediate for pesticides, pharmaceuticals and amber dyes (Lewis, 1993).

Environmental Fate and Hazard. If released into the air, vapor pressure indicates thiophenol will exist solely as a vapor in the ambient atmosphere. Vapor-phase thiophenol will be degraded in the atmosphere by reaction with photochemically-

produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 34 hours. In the soil, thiophenol is expected to have low mobility based upon an estimated K_{oc} of 560. The pKa of thiophenol is 6.62, indicating that this compound will exist partially in anion form in the environment and anions generally adsorb to organic carbon and clay less strongly than their neutral counterparts. Volatilization from moist soil surfaces is expected to be an important fate; however, volatilization from water surfaces may not be an important fate process as the anion is not expected to volatilize. Thiophenol may volatilize from dry soil surfaces based upon its vapor pressure. If released into water, thiophenol is expected to adsorb to suspended solids and sediment based upon the estimated K_{oc}. In water, using an activated sludge inoculum, thiophenol reached 30-42% of its theoretical biological oxygen demand (BOD) in 6 days. Volatilization from water surfaces is expected to be an important fate process based upon this compound's estimated Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 3 hrs and 5 days. Thiophenol is not expected to undergo hydrolysis in the environment due to the lack of hydrolyzable functional groups (USNLM, 2003).

An estimated BCF of 17 suggests the potential for bioconcentration in aquatic organisms is low. Acute oral LD_{50} for mouse and rat were 267 mg/kg and 134 mg/kg. The acute dermal LD_{50} for rabbit and rat were 134 mg/kg and 300 mg/kg. The draize test was applied to a rabbit eye at 108 mg resulting in a severe reaction. Teratogenic effects were noticed on female rats after 6-15 days after conception-post implantation found effects on litter size and fetus.

Human Hazards. Occupational exposure to thiophenol may occur through inhalation and dermal contact with this compound at workplaces where thiophenol is produced or used. Thiophenol may be fatal if ingested, inhaled, and absorbed through the skin. It is a methemoglobin forming agent, and combustible liquid and vapor. It may cause central nervous system depression. This substance has caused adverse reproductive and fetal effects in animals. Exposure can affect the kidneys, central nervous system, liver, nerves, and adrenal medulla (Mallinckrodt, 2003). Thiophenol is not listed as a carcinogen by ACGIH, NIOSH or OSHA. The PEL limit is 0.1 ppm (0.5 mg/m^3 15-minute) (NIOSH, 2003).

Trimethylamine (TMA) [CAS 75-50-3]

General Information. Trimethylamine is a colorless gas at room temperature and is readily liquidified. Its anhydrous form is shipped as liquified compressed gas and has a fishy ammoniacal odor. It is soluble in water, alcohol, and ether. Production and use of

trimethylamine in chemical synthesis may result in its release to the environment through various waste streams. It is used in organic synthesis, especially of chlorine salts, warning agent for natural gas, manufacture of disinfectants, and insect attractant (Lewis, 1993). Trimethylamine is widely distributed in the environment as a result of its formation during the decay of organic matter in plants, animals, fish, sewage, and animal waste.

Environmental Fate and Hazard. A vapor pressure of 1.6 $x10^{+3}$ mm Hg (25 °C) indicates trimethylamine will exist solely as a gas in the ambient atmosphere. Gas-phase trimethylamine will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 9 hrs. If released in the soil, trimethylamine is expected to have very high mobility based upon an estimated K_{oc} of 29. The pKa of trimethylamine is 9.8. At pH 8.8, 10% of trimethylamine will be the free amine. Thus, this compound will primarily exist in cation form in the environment and cations generally adsorb to organic carbon and clay more strongly than their neutral counterparts. Trimethylamine will have a greater adsorption and less mobility than its estimated K_{oc} value indicated (USNLM, 2002). Volatilization of trimethylamine from moist soil surfaces will not be an important fate process because cationic trimethylamine does not volatilize. Therefore, volatilization will not be important except at very high pH values. Trimethylamine may volatilize from dry soil surfaces based upon its vapor pressure. Microbial production of dimethylamine from trimethylamine in soil was found to be greater under acidic conditions than at near neutral pH and greater under aerobic conditions than anaerobic conditions. In the water, it is not expected to adsorb to suspended solids and sediment based upon the estimated K_{oc}. However, trimethylamine has a pKa of 9.8 and should exist primarily as a cation under ideal conditions (pH 5-9). As a result, trimethylamine may have greater adsorption to suspend to solids and sediment than its estimated Koc value indicates. Volatilization from water surfaces will not be an important fate process except at very basic conditions. Trimethylamine incubated in marine sediment slurry underwent about 35% removal, as measured by production of CARBON DIOXIDE and CH_4, in 12 hours. Degradation products formed under aerobic conditions include dimethylamine, formaldehyde, formate, and CARBON DIOXIDE, while products formed under anaerobic conditions include dimethylamine, NH_4, and CH_4. Hydrolysis is not expected to occur due to the lack of hydrolyzable functional groups (USNLM, 2002).

An estimated BCF of less than 1 suggests the potential for bioconcentration in aquatic organisms is low.

Human Hazards. Occupational exposure to trimethylamine may occur through inhalation and dermal contact with this compound at workplaces where trimethylamine is

produced or used. Monitoring data indicates that the general population may be exposed to trimethylamine via inhalation of tobacco smoke, and ingestion of foods in which trimethylamine occurs. Trimethylamine may cause severe eye and skin irritation with possible burns and severe respiratory and digestive tract irritation with possible burns. The PELs are 5 ppm TWA, 15 ppm STEL established by ACGIH, while NIOSH established a 10 ppm TWA and 24 mg/m^3 TWA. It is not listed as a carcinogen by NIOSH, OSHA, or ACGIH (Acros Organics, 2003).

Discussion. Trimethylamine is an extremely flammable liquid and care should be taken when handling. Personnel handling trimethylamine should use PPE.

Tungsten (VI) Fluoride (WF_6) [CAS 7783-82-6]

General Information. Tungsten (VI) Fluoride is manufactured as a gas, crystal, or liquid. Its appearance can be from colorless to yellow with no odor. It reacts with water violently. The average tungsten concentration in the earth's crust is about 0.006%. Tungsten occurs naturally as tungstate, mainly in compounds such as wolframites and scheelites. Tungsten compounds are produced and used as catalysts (e.g., tungsten oxides and sulfides); cutting and forming tools (e.g., tungsten carbide); filaments (e.g., tungsten metal and alloys); and dyes and pigments (e.g., organic rodenhousetungsten) (USNLM, 2002).

Environmental Fate and Hazard. Small concentrations of tungsten have been released into the atmosphere primarily as industrial emissions and nuclear fall-out. Tungsten compounds have low vapor pressures and exist as particulate matter in the atmosphere. Particulate-phase tungsten compounds may be removed from the air by wet and dry deposition. Tungsten compounds will have moderate to low mobility in the soil based upon sorption coefficients ranging from 10 to 50,000 at pH 5 to 6.5. Tungsten compounds will exist as ions or insoluble solids in the environment and therefore volatilization from moist soil surfaces will not be an important fate process. Tungsten compounds will not volatilize from dry soil surfaces based upon their ionic character and low vapor pressures. If released in the water, tungsten compounds will adsorb to suspended solids and sediment based upon their sorption coefficients. Tungsten in natural waters is in the form of tungstate (i.e., WO_4^{-2}) and other tungsten polyanions.

Human Hazards. Occupational exposure to tungsten compounds may occur through inhalation of dust and dermal contact with this compound at workplaces, where tungsten compounds are produced or used. Containers containing tungsten (VI) fluoride may rupture or explode if exposed to heat and may ignite combustibles. Tungsten (VI)

fluoride at times reacts violently with water to generate toxic and/or flammable gases. The PEL is 2.5 mg/m^3 TWA (OSHA, NIOSH) (Matheson Tri-Gas, Inc., 2003). It is not listed as a carcinogen by NIOSH or NTP (U.S Department of Health and Human Services, 2002).

12.0 ALTERNATIVE TWO

Chemical Simulants

Bis(2-ethylhexyl) phosphate (DEPHA) [CAS 298-07-7]

General Information. DEPHA has an appearance of a light-yellow liquid and is slightly soluble in water. DEPHA is used as an additive to lubrication oils, a corrosion inhibitor, and an antioxidant. Its other uses have included metal extraction and separation, and a fire retardant in polymeric material or in other materials (USNLM, 2002).

Environmental Fate and Hazards. The release of DEPHA in the environment is expected to occur during the manufacture of certain lubricating oils, wetting agents, detergents, and during heavy metal extraction. The hydrolysis of DEPHA may be important in the environment at basic pH, but no rate data is available to quantify the relative importance of the process. Biodegradation data for soil and water were not available. DEPHA adsorption to suspended solids and sediments in water and soil should be moderately strong. The adsorption should become weaker as the pH of the media increases. Based on the estimated Henry's Law constant and vapor pressure, the volatilization of the compound from water and soil should not be important. In the atmosphere, the reaction of DEPHA with photochemically produced hydroxyl radicals may be an important process. The half-life of this reaction has been estimated at 6.2 hours (USNLM, 2002).

The BCF for DEPHA has been estimated to be 1230, as a result bioconcentration of DEPHA in aquatic organisms may occur (USNLM, 2002). The acute oral and intraperitonal LD_{50} in rats was 4.94 mL/kg and 50 mg/kg (DEPHA, 1997)

Human Hazards. Exposure of workers is likely to occur from using DEPHA during the manufacture of certain lubricating oils, wetting agents and detergents. Workers in the radiochemical industry, where DEPHA is used for the extraction of radioactive metals, are also susceptible to exposure to this compound. Routes of exposure are by ingestion, dermal, inhalation, and eye contact. DEPHA is corrosive and extremely destructive to tissues of the mucous membranes and upper respiratory tract. If ingested, it can cause severe burns in the mouth, throat, and stomach, and cause vomiting, diarrhea.

Discussion. DEPHA is not expected to evaporate considerably from the soil or water. In the air, it is expected to be degraded by reaction with photochemically produced hydroxyl radicals.

Risk of exposure to DEPHA by test personel will be minimized with the use of PPE. The generall population will not be impacted by DEPHA. DEPHA will most likely adsorb to soil, but it is unlikely to leach into the groundwater because of its low solubility. It will possibly bioaccumlate in organisms and persist in soil.

2-Chloroethyl ethyl sulfide (CEES) [CAS 693-07-2]

General Information. 2-chloroethyl ethyl sulfide is clear slightly yellow liquid with a sulfide odor. 2-chloroethyl ethyl sulfide is slightly soluble in water. 2-chloroethyl ethyl sulfide is used as an intermediate in the production of pesticides. Its production and use as a simulant for mustard gas and in studies involving decontamination, detection, contact hazards, and clothing protection may result in its release to the environment through various waste streams (USNLM, 2002).

Environmental Fate and Hazards. When released into the air, it has a vapor pressure of 3.4 mm Hg that indicates 2-chloroethyl ethyl sulfide will exist solely in the vapor-phase in the ambient atmosphere. Vapor-phase 2-chloroethyl ethyl sulfide will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the estimated half-life for this reaction was 32 hours. In the soil, 2-chloroethyl ethyl sulfide is expected to have high mobility. Volatilization from moist soil surfaces will not be an important fate process due to its hydrolysis rate; the extrapolated hydrolysis half-life of 2-chloroethyl ethyl sulfide in pure water at $25^{o}C$ is about 44 seconds. Due to rapid hydrolysis, leaching in soil will not have an effect. 2-chloroethyl ethyl sulfide may volatilize from dry soil surfaces based upon its vapor pressure. The extrapolated hydrolysis half-life of 2-chloroethyl ethyl sulfide in pure water from studies in ethanol-water and acetone water at 25° deg C is about 44 seconds (USNLM, 2002).

The acute oral LD_{50} found in rats was 252 mg/kg and the lowest published lethal dose (LDLo) subcutaneous found in mice was 25mg/kg. When tested it was found to be mutagenic, causing DNA damage in *Escherichia coli* (*E. coli*) (CEES, 1997).

Human Hazards. Occupational exposure to 2-chloroethyl ethyl sulfide may occur through inhalation, eye, digestive, and dermal contact at workplaces where it is produced or used (Acros, 2003). It can cause severe eye and skin irritation and may cause chemical conjunctivitis and corneal damage and causes blistering of the skin. Effects may be delayed but may cause cyanosis of the extremities. If swallowed, it may cause

gastrointestinal irritation with nausea, vomiting, and diarrhea. Ingestion of large amounts may cause CNS depression. When inhaled, it can cause severe respiratory tract irritation and aspiration may lead to pulmonary edema (Acros, 2003).

Discussion. 2-chloroethyl ethyl sulfide may leach into the ground water due to moderate water solubility.

Risk of exposure to 2-chloroethyl ethyl sulfide by test personnel will be minimized with use of PPE. 2-chloroethyl ethyl sulfide is not expected to have any impact on the general population.

Diethyl methyl phosphonate (DEMP) [CAS 683-08-9]

General Information. Diethyl methyl phosphonate is a clear liquid. Diethyl methylphosphonate is a by product of O-Isopropyl methylphosphonofluoridate (sarin or GB) a chemical weapon, which is mandated by the Chemical Weapons Convention (CWC).

Environmental Fate and Hazards. The acute oral LD_{50} for mice was 2240 mg/kg. Hazardous products that are associated with decomposition are carbon monoxide, carbon dioxide, and thermal decomposition may produce toxic fumes of phosphorus oxides and/or phosphine.

Human Hazards. DEMP is irritating to eyes, respiratory system and skin. No sensitizing effects are known. Organic phosphorus compounds exhibit a wide range of toxicity. Those exhibiting substantial water reactivity will have stronger irritating properties and may be corrosive enough to cause burns. Some organic phosphorus compounds are cholinesterase inhibitors. Symptoms associated with these include muscle twisting, convulsions, flaccid paralysis, coma, respiratory failure. They can be highly paralytic (Alfa Aesar, 1999b).

Discussion. No OEL was found for DEMP in the available literature. Like many chemicals, DEMP is a hazardous by product compound, but with the correct use of PPE, personnel shall minimize any risk to their safety. The surrounding population and animals will be at little risk of exposure by DEMP based on high LD_{50}. The proximity of the general population to WSMR will be unlikely affected by the release of DEMP.

Diisopropyl fluoro phosphate (DFP) [CAS 55-91-4]

General Information. DFP is a viscous, oily liquid that decomposes to form hydrofluoric acid, when in water. It is used as an insecticide (in dilute form) and in military applications (Bennett, 1984).

Environmental Fate and Hazards. The production and use of diisopropyl fluorophosphate may result in its release to the environment through various waste streams. If released to air, DFP will exist solely in the vapor-phase in the ambient atmosphere. Vapor-phase diisopropyl fluorophosphate will be degraded in the atmosphere by reaction with photochemically produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 5 hours. If released to soil, diisopropyl fluorophosphate is expected to have very high mobility, and volatilization from moist soil surfaces is expected to be an important fate process. Diisopropyl fluorophosphate will not volatilize from dry soil surfaces based upon its vapor pressure. When released into water, diisopropyl fluorophosphate is not expected to adsorb to suspended solids and sediment. Volatilization from water surfaces is expected to be an important fate process and its estimated volatilization half-lives for a model river and model lake are 250 hours and 120 days, respectively. Diisopropyl fluorophosphate undergoes hydrolysis to hydrofluoric acid (HF) and diisopropyl phosphate, and half-lives range from 16.7 hours to 2.2 days at temperatures of 37^{o} to 25^{o} C and 72 hours to several days at temperatures of 15^{o} to 30^{o} C (USNLM, 2003).

An estimated BCF of 1 suggests that the potential for bioconcentration in aquatic organisms is low. The acute oral LD_{50} for diisopropyl fluorophosphate is 9.8 mg/kg for rabbits, 6 mg/kg for rats, and 37 mg/kg for mice. DFP has the potential to affect wildlife due to DFP's ability to temporarily interfere with the action of cholinesterase (Bennett, 1984).

Human Hazards. Occupational exposure to diisopropyl fluorophosphate may occur through dermal contact with this compound at workplaces where diisopropyl fluorophosphate is produced or used. This is an organophosphate pesticide and is extremely toxic. Probable oral lethal dose in humans is 5-50 mg/kg, between 7 drops and 1 teaspoonful for 70 kg person (150 lb.). The material is a cholinesterase inactivator; even traces of the vapor cause pinpoint pupils (United States EPA, 1987).

Discussion. Diisopropyl fluorophosphate is expected to have very high mobility and volatilization from moist soil surfaces is likely to leach. It will unlikely absorb to the soil and bioaccumulate in the environment or in organisms due to a biocentration factor of one and its solubility. However, acute animal toxicity appears to be high, given the low

LD_{50} values. Possible toxicity effects could arise within the animal populations with the use of DFP.

The utilization of PPE on test personal will minimize the danger and exposure to DFP. DFP is not expected to have an impact on the general population.

Diisopropyl methyl phosphonate (DIMP) [CAS 1445-75-6]

General Information. Diisopropyl methylphosphonate is not produced commercially. It is a byproduct in the production of the chemical agent sarin (GB), constituting up to 20% of the chemical agent, and may also be used to simulate G-type chemical agents. DIMP has no known industrial or consumer application.

Environmental Fate and Hazards. DIMP has been identified as a groundwater contaminant on or near sites of former chemical warfare production facilities. If released into air, DIMP will exist solely in the vapor-phase in the atmosphere. DIMP will be degraded photochemically and the reaction in air is estimated to be 5 hours. DIMP does not adsorb radiation; therefore, direct photolysis cannot occur. If released to soil, DIMP is expected to have high mobility and volatilization from dry soil surfaces is expected to be slow. Diisopropyl methylphosphonate volatilized in 10 days when applied to dry and moist soil. Biodegradation in acclimated and unacclimated soil takes about 1 and 3 years.

When released into water, DIMP is not expected to adsorb to suspended solids and sediment based on its K_{OC}. An estimated volatilization half-life for a both river and lake models are 31 hours and 13 days, respectively.

The potential for bioconcentration in aquatic organisms is low. DIMP does hydrolyze, primarily by a base-catalyzed reaction resulting in isopropanol and isopropyl methylphosphonate, this hydrolysis is very slow and will not have an effect.

Human Hazards. Occupational exposure to DIMP may occur through inhalation and dermal contact with this compound at work facilities or military workplaces where DIMP is produced or used. DIMP is not classifiable as a human carcinogen from the available information. EPA adapted an allowable concentration, through its Federal Drinking Water Guidelines, of 600ug/L (USEPA, 1993).

Discussion. DIMP is expected to have high mobility in soil and volatilize from dry soil surfaces is expected to be slow. In water, it is not expected to adsorb to suspended solids and sediment. DIMP is not expected to bioaccumulate according to the available literature. DIMP has a high solubility and could leach into the groundwater. Risk of

exposure or injury to test personnel will be minimized with the use of proper personal protective equipment and corrective procedures.

Tracers and Taggants

Lead (II) Selenide [CAS 12069-00-0]

General Information. Lead (II) selenide are gray crystals that are insoluble in water and soluble in nitric acid. It is used as a semiconductor in infrared detectors and thermoelectric devices (Lewis, 1993).

Environmental Fate and Hazards. Little is known about environmental fate of lead (II) selenide. When lead compounds are released or deposited on soil, most will be retained in the upper 2 - 5 cm of soil. In soil, lead is expected to slowly convert to more insoluble forms such as sulfate, sulfide, oxide, and phosphate salts. The uptake of lead from soil into plants is generally not significant. Lead can enter surface water from atmospheric fallout, runoff or wastewater. Organolead complexes are formed with humic materials, which maintain lead in a bound form even at low pH. Lead is therefore effectively removed from the water column to the sediment by adsorption to organic matter and clay minerals.

When released to the atmosphere, lead will generally occur as particulate matter and is subject to gravitational settling; later it will be transformed to the oxide and carbonate forms. The atmospheric half-lives of trimethyl- and triethyl lead are 126 and 34 hrs, respectively which is about three times greater than that of the corresponding tetraalkyl lead compounds.

Lead does not appear to bioconcentrate significantly in fish. Freshwater algae are affected by concentrations of lead above 500 µg/L based on data for four species (USEPA, 1984).

Human Hazards. Lead (II) selenide is a moderate fire risk as dust or in presence of moisture (Lewis, 1993). Exposure may occur by inhalation, ingestion, eye and skin absorption. There is no established PEL for lead (II) selenide, however for lead compounds the PEL is 0.005 mg/m^3/8 hours TWA (OSHA) and 0.002 mg/m^3/8hours TWA (ACGIH) (Evident Technologies, 2002). From the available literature, lead is known to be a potential carcinogen. Death from lead poisoning may occur in children who have blood lead levels greater than 125 µg/dL and brain and kidney damage have been reported at blood lead levels of approximately 100 µg/dL in adults and 80 µg/dL in children (ASTDR, 1997).

Discussion. Risk of exposure or injury to test personnel will be minimized with the use of proper PPE and corrective procedures. Lead (II) selenide is not expected to have any impact on the general population.

Lead (II) selenide could have an impact on terrestrial or aquatic environments at and near DTRA test beds. It has the possibility of absorbing to the soil or sediment, and bioaccumulating in organisms.

Lead (II) Telluride [CAS 1314-91-6]

General Information. Lead (II) telluride is a crystalline solid and insoluble in water. It is used in single crystals in photoconductors, semiconductors, and thermocouples (Lewis, 1993).

Environmental Fate and Hazards. From available information, lead (II) telluride is found to be toxic to aquatic organisms and may cause long-term adverse effects in the aquatic environment. Hazardous decomposition products are lead/lead oxides and hydrogen chloride gas (Sigma-Aldrich, 2004).

Human Hazards. It is harmful by inhalation and ingestion. The danger of cumulative effects could result in the risk of impaired fertility. Adverse effects of lead on human reproduction, embryonic and fetal development, and postnatal (e.g., mental) development have been reported. The teratogenic effects of lead (II) telluride are congenital malformation in the fetus. The target organ(s) of lead telluride are the cardiac system (blood) and central nervous system. Excessive exposure can affect blood, nervous, and digestive systems. If left untreated, neuromuscular dysfunction, possible paralysis, and encephalopathy can result. High body levels produce increased cerebrospinal pressure, brain damage, and stupor leading to coma and often death (Sigma-Aldrich, 2004). No OEL has been established, but the PEL for lead is 0.05 mg/m^3 (NIOSH, 2003).

Discussion. Test personnel exposed to lead (II) telluride will be minimized if PPE is used. Lead (II) telluride is not expected to have any impact on the general population. It has the potential of absorbing to the soil or sediment, while possibly bioaccumulating due to its solublity.

Mercuric Sulfuric Red [CAS 1344-48-5]

General Information. Mercuric sulfuric red, also known as mercuric sulfide, occurs as a heavy amorphous powder, as black cubic crystals (mercuric sulfide, black) a powder, as lumps, or as hexagonal crystals (mercuric sulfide, red). Mercuric sulfide transitions from

red to black at 386 °C. Black mercuric sulfide sublimes at 446 °C, and red mercuric sulfide at 583 °C. Black mercuric sulfide is insoluble in water, alcohol, and dilute mineral acids. Red mercuric sulfide is insoluble in water, but dissolves in aqua regia (with separation of sulfur) and warm hydriodic acid (with the evolution of hydrogen sulfide). Black mercuric sulfide is also known as etiops mineral. Red mercuric sulfide is also known as vermilion, Chinese red, Pigment Red 106, C.I.77766, quicksilver vermilion, Chinese vermilion, artificial cinnabar, and red mercury sulfured (ATSDR, 1999).

Environmental Fate and Hazards. Mercuric sulfide is the predominant natural form of mercury in the environment and is a common ore from which metallic mercury is derived. Mercury released to the environment may be transformed into mercuric sulfide. Several studies suggest that the bioavailability of mercuric sulfide in animals is less than that of mercuric chloride. For example, Sin et. al. (1983) found an increase in tissue levels of mercury in mice orally exposed to low doses of mercuric chloride, but elevated levels of mercury were not found in the tissues of mice fed an equivalent weight of mercuric sulfide. The findings indicate a difference in availability between $HgCl_2$ (mercuric chloride) and HgS (mercuric sulfide) in mice. A quantitative determination of the relative bioavailability of mercuric sulfide versus mercuric chloride has not been derived in the available studies, nor has the relative bioavailability of mercuric sulfide in humans been examined (ATSDR, 1999). Hazardous decomposition products are mercury/mercury oxides and sulfur oxides. The acute LD_{50} for rat was 8 mg/kg and 5 mg/kg from different mercury compounds (USNLM Mercury compounds, 2003).

Human Hazards. Mercuric sulfuric red causes eye and skin irritation. It is toxic if ingested or absorbed through the skin; kidneys, G.I. and central nervous system are the primary organs that are affected. Overexposure to mercury compounds can cause neurotoxic effects, nausea, vomiting, and diarrhea. The EPA has not classified mercury as a carcinogen based on the absence of data in humans and limited evidence of carcinogenicity in rats and mice (USEPA, 1999). A OEL for mercuric sulfide has not been established, but the PEL for mercury is 0.05 mg/m^3 TLV-TWA (ACGIH) and 0.05 mg/m^3 as an 8-hour TWA (NIOSH, 2003). The acute lethal dose for most inorganic mercury compounds for an adult is 1 to 4 grams or 14 to 57 milligrams per kilogram body weight (mg/kg) for a 70-kg person (ASTDR, 1999)

Discussion. Mercuric sulfuric red is likely to build up concentrations in soil based on its insolubility. Effects of mercuric sulfuric red on vegetation and soil microbes are not known, so it is not possible to assess effects of mercuric sulfuric red on plants, soil microbial processes, or indirect effects on animal populations at DTRA test beds.

Test personnel exposed to mercuric sulfuric red will be minimized, if PPE is used. Mercuric sulfuric red is unlikely to have some impact on the general populations because the nearest population is 16 km from the DTRA test beds.

Mercury Selenide [CAS 20601-83-6]

General Information. Mercury selenide sublimes in a vacuum and is insoluble in water. It is used in semiconductor in solar cells, thin-film transistors, infrared detectors, and ultrasonic amplifiers (Lewis, 1993).

Environmental Fate and Hazards. Due to its insolubility, it has the potential to adsorb and bioaccumulate in the soil. It is unlikely to leach into the ground water and its mobility through the soil will be slow. Hazardous decomposition products are mercury/mercury oxides and selenium/selenium oxides. The acute LD_{50} for a rat was 8 mg/kg and 5 mg/kg from different mercury compounds (USNLM Mercury compounds, 2003).

Human Hazards. Routes of exposure are by inhalation, digestion, eye amd skin adsorption. It may cause eye and skin irritation. Principle target organs are the kidneys and central nervous systems. Signs of chronic exposure to selenium compounds are garlic odor of breath and sweat, dermatitis, and moderate emotional instability. Prolonged exposure can cause neurotoxic effects, dizziness, nausea, and diarrhea. Exposure to mercury compounds can cause tremors, loss of appetite, weight loss, anuria, and uremia. Acute selenium poisoning produces central nervous system effects, which include nervousness, convulsions, and drowsiness (Sigma-Aldrich, 2004). Other signs of intoxication can include skin eruptions, lassitude, gastrointestinal distress, teeth that are discolored or decayed, odorous ("garlic") breath, and partial loss of hair and nails. Chronic exposure by inhalation can produce symptoms that include pallor, coating of the tongue, anemia, irritation of the mucosa, lumbar pain, liver and spleen damage, as well as any of the other symptoms listed above (Sigma-Aldrich, 2004). The acute lethal dose for most inorganic mercury compounds for an adult is 1 to 4 grams or 14 to 57 milligrams per kilogram body weight (mg/kg) for a 70-kg person (ASTDR, 1999). An OEL was not available or has been established; however, the PEL for mercury compounds compounds is 0.1 mg/m^3 TLV (ACGIH).

Discussion. Environmental toxicity of mercury selenide has not been widely studied. Because mercury compounds are of low acute toxicity to rats, mice and rabbits, it is expected that mercury selenide will possibly impact small mammal populations at DTRA test beds. The effects of mercury selenide on flora and fauna have not been researched to

determine their potential impacts. Risk of exposure to mercury selenide by test personnel will be minimized with use of PPE.

Mercury selenide will unlikely leach into the groundwater, however in has the potential to absorb to the soil based on its insolubility. It also has the potential to bioaccumulate.

Mercury Telluride [CAS 12068-90-5]

General Information. Mercury tellurides are odorless black chunks that are insoluble in water. It is used in semiconductors, solar cells, thin-film transistors, infrared detectors, and ultrasonic amplifiers (Lewis, 1993).

Environmental Fate and Hazards. Little information is known about the environmental fate of mercury telluride. It will not likely leach into the ground water because of its insolubility. Its rates of degradation are unknown; it is not possible to determine mercury telluride persistence in the environment. However based on some mercury compounds, they can enter the atmosphere in the particulate phase based on their low to nonexistent vapor pressures. Deposition with precipitation is a major factor in removing mercury compounds from the atmosphere however, if they are not subjected to wash-out or dry deposition processes, they will likely be transformed by chemical or physical processes in the atmosphere. Exchange reactions between water and mercury compounds are likely to occur in the atmosphere. The effect of these exchange reactions results in the release of elemental mercury into the gas phase. Inorganic mercury compounds cans be methylated by microorganisms indigenous to soils, fresh water, and saltwater. The process is mediated by various microbial populations under both aerobic and anaerobic conditions. Exchange reactions between water and mercury compounds may result in the release of elemental mercury into the environment. Once mercury compounds are released into moist soil environments, they may disassociate depending upon their solubility. Upon dissolution, mercury will either be associated with its respective anion or be associated with humic matter. Studies indicate that mercury compounds, once deposited on soil are absorbed to the soil and do not leach. Mercuric sulfide has been found to strongly adsorb to soil, and even with weathering any mercury released from the mercuric sulfide is reabsorbed by the soil. Inorganic mercury compounds are not expected to volatilize from moist soils or water surfaces because of their low Henry's law constants. Mercury compounds are not expected to bioconcentrate unless they are converted to methyl mercury in the environment. Conversion of inorganic mercury compounds to methyl mercury can occur within 30 to 50 days in the environment (USNLM Mercury compounds, 2003).

The acute LD_{50} for rat was 8 mg/kg and 5 mg/kg from different mercury compounds (USNLM Mercury compounds, 2003).

***Human Hazards*.** Acute and chronic exposure to inorganic mercury can cause salivation with metallic taste, pain on chewing, gingivitis, colitis, stomatitis, kidney damage, and central nervous system damage. The latter can cause tremors, convulsive or shaking movements, and psychic disturbances such as memory loss, insomnia, or depression with excessive exposure resulting in death. Tellurium is converted in the body to dimethyl telluride that imparts a garlic-like odor to the breath and sweat. Heavy exposure may result in headaches, drowsiness, metallic taste, loss of appetite, nausea, tremors, convulsions, and respiratory arrest. An OEL was not available or has been established; however, the PEL for mercury compounds and tellurim compounds is 0.1 mg/m^3 TLV (ACGIH). The acute lethal dose for most inorganic mercury compounds for an adult is 1 to 4 grams or 14 to 57 milligrams per kilogram body weight (mg/kg) for a 70-kg person (ASTDR, 1999).

Discussion. Mercury telluride will unlikely leach into the ground water and it has the potential to absorb and bioaccumulate to the soil in either water or land, based on its on insolubility. Its rates of degradation are unknown, it is not possible to determine mercury telluride persistence in the environment, but should have the same rate of degradation as mercury or mercury compounds.

Test personnel exposed to mercury telluride will be at minimal risk, if PPE is used. Mercury telluride is unlikely to impact the general population. Mercury telluride could have an impact on terrestrial or aquatic environments because of mercury’s known toxicity.

13.0 ABBREVIATIONS AND ACRONYMS

µL	micro liter
ACGIH	American Conference of Industrial Hygienists
ALOHA	Areal Locations of Hazardous Atmospheres
ANFO	ammonium nitrate - fuel oil
AN	ammonium nitrate
APAM	anti-personnel anti-materiel
ASL	above sea level
ATC	Air Traffic Control
ATCAA	Air Traffic Control Assigned Airspace
ATL	Advanced Tactical Laser
atm-cu m/mole	atmosphere cubic meter per mole
BC	before Christ
BCF	Bioconcentration factor
Bg	*Bacillus subtilis*
Bg.	Bacillus subtilis
BIDS	Biological Integrated Detection System
BLESTS	Beam Loaded Explosive Simulation Test
BLU	bomb live unit
BOD	biological oxygen demand
Bt	*Bacillus thuringiensis*
Bt.	Bacillus thuringiensis
C	celisus
C-4	Composition 4
CA	California
CBR	chemical, biological and radiological (simulants)
cc	cubic centimeter
CDC	Center of Disease Control and Prevention
CEQ	Council on Environmental Quality
CFC	chlorofluorocarbons
CFU	colony forming units
CFU	Colony Forming Unit
CH_4	methane
chem/bio	chemical/biological
CIST	cylindrical insitu tests
cm	centimeters
CNS	central nervous system
CO	carbon monoxide
CO_2	carbon dioxide
CW	chemical weapons
CWC	Chemical Weapons Convention
DIMP	diisopropyl methyl phosphonate
DMMP	dimethyl methyl phosphate
DoD	Department of Defense
DPM	dowanol glycol ether
DTRA	Defense Threat Reduction Agency
EA	environmental assessment
EC_{50}	median effective concentration
ECOTOX	Environmental Protection Agency ECOTOXicology
EH	*Erwinia herbicola*

EIS	environmental impact statement
EPA	Environmental Protection Agency
ERPG	Emergency Response Planning Guidelines
F	Fahrenheit
FCDSWA	Field Command, Defense Special Weapons Agency
FO	fuel oil
g	gram
gm	gram
H_2SO_4	sulfric acid
HE	high explosive
Hg	mercury
HMX	cyclotetramethylenetetranitramine
HNO_3	nitric acid
HPAC	Hazard Prediction and Assessment capability
HPAC	Hazard Prediction and Assessment Capability
hr	hour
IDLH	immediately dangerous to life and health
IARC	International Agency for Research on Cancer.
IRFNA	inhibited red fuming nitric acid
IU	international units
Kg	kilogram
Km	kilometer
K_{oc}	Soil Organic Carbon / Water Partitioning Coefficient
L	liters
lb	pound
LC_{100}	lethal concentration (absolute)
LC_{50}	lethal concentration at which 50% of test subjects die
LCLo	lowest published lethal concentration
LD_{50}	lethal dose at which 50% of test subjects die
LDH	Lactic dehydrogenase
LOC	levels of concern
m	meter
m^2	meter square
m^3	meter cube
MCL	Maximum Contaminant Level
MeS	methyl salicylate
µl/kg	microliter per kilogram
mg	milligram
mg/m^3	milligram per meter cubic
ml	milliliter
mm	millimeter
mM	millimolar
min	minute
MS2	MS2 bacteriophage/phage
MSDS	material safety data sheet
MSL	mean sea level
MTR	military training routes
MW	molecular weight
NBC	nuclear, biological, and chemical
NEPA	National Environmental Policy Act

NFPA	National Fire Protection Association
ng	nanogram
NH_4	ammonium
NIOSH	National Institute for Occupational Safety and Health
ng/m^3	nanogram per cubic meer
nm	nanometer
NM	nitromethane (or New Mexico)
NO_2	nitrogen dioxide
NTP	National Toxicology Program
NY	New York
O_3	ozone
OEL	occupational exposure limit
OSHA	Occupational Safety and Health Administration
OV	ovalbumin
PBX	plastic bonded explosives
PEL	permissible exposure limit
PETN	pentaerythritol tetranitrate
PHETS	Permanent High Explosive Test Site
pKa	acid ionization constant
PM_{10}	respirable particulate matter
PMMA	polymethyl methacrylate
POL	petroleum, oil, and lubricants
PPE	personal protection equipment
ppm	parts per million
PSBA	polystyrene-butylmethacrylate
REL	recommended exposure level
RDX	cyclotrimethylenetrinitramine
RNA	ribonucleic acid
SBCCOM	United States Army Soldier Biological Chemical Command
SHIST	Seismic Hardrock In Situ Test
SO_2	sulfur dioxide
SOP	standard operating procedure
sp	one species
spp	multiple species
STEL	Short Term Exposure Limit
TATB	Triamino-trinitrobenzene
TBP	Tributyl phosphate
TDG	Thiodiglycol
TDLo	Lowest published toxic dose
TEEL	Temporary Emergency Exposure Limits
TEP	triethyl phosphate
TEPI	Triethyl phosphate
TLV	Threshold Limit Value
TNT	trinitrotoluene
TWA	Time Weighted Average
U.S.	United States
UDMH	Unsymmetrical Dimethyl Hydrazine
ug	micrograms
UV	ultraviolet
UXO	unexploded ordnance

VX	O-ethyl S-(2-diisopropylaminoethyl) methylphosphonothioate (nerve gas)
WMD	weapons of mass destruction
WS-ES	White Sands Environmental Services Division
WSMR	White Sands Missile Range
yr	year

14.0 GLOSSARY

A

abundance - The total number of organisms in a biological community.

acetylcholinesterase - an enzyme that occurs especially in some nerve endings and in the blood and promotes the hydrolysis of acetylcholine.

adrenal medulla - the inner portion of the adrenal gland. The adrenal medulla secretes the stress hormones noradrenaline and adrenaline.

aerobic - occurring only in the presence of oxygen.

agranulocytosis - an acute blood disorder (often caused by radiation or drug therapy) characterized by severe reduction in granulocytes.

albic - a bleached, light colored horizon from which the clay and free iron oxides have been removed.

algae blooms - massive growths of microscopic and macroscopic plant life, algae which develop in water bodies.

allotropic - the existence of a substance and especially an element in two or more different forms (as of crystals) usually in the same phase

American Conference of Governmental Industrial Hygienists, (ACGIH) - This organization include professionals in government and education involved in occupational safety and health programs. One important function of this group is the determination and publication of recommended occupational exposure limits for chemical substances.

amorphous - having no definite form.

anhydrous - without water.

anesthesia - loss of sensation with or without loss of consciousness.

anthropogenic - produced by human activities.

antiseptic - preventing the growth of microorganisms.

antioxidant - a substance that inhibits oxidation or reactions changed by oxygen or peroxides.

aqueous - made from or related to water

arrhythmia - an alteration in rhythm of the heartbeat.

asphyxiant - is a substance that can cause unconsciosness or death by suffocation.

B

bacteriophage – a virus that infects bacteria.

bacterium - any of a group (as kingdom Procaryotae syn. Monera) of prokaryotic unicellular round, spiral, or rod-shaped single-celled microorganisms that are often aggregated into colonies or motile by means of flagella, that live in soil, water, organic matter, or the bodies of plants and animals, and that are autotrophic, saprophytic, or parasitic in nutrition and important because of their biochemical effects and pathogenicity.

bilateral - having two sides.

bioaccumulation - a progressive increase of the bodily content of a compound.

bioconcentration - the accumulation of a chemical in tissues of a fish or other organism to levels greater than that in the surrounding medium (environment).

bioconcentration factor - the ratio of chemical concentration in the organism to that in surrounding water.

biological oxygen demand (BOD) - a measure of the amount of oxygen needed by aquatic organisms to break down solids and other degraded organic matter present in waste water or water.

biological stimulant - a biological substance, or microorganism that shares at least one physical or biological characteristic of a biological agent, has been shown to be non-pathogentic, and can be used for biological defense testing to replace the agent under study.

biomagnification - an increase in concentration of a pollutant from one link in a food chain to another.

biotransformation - the trans formation of chemical compounds within a living system.

blasthole - is a cylindrical vehicle designed and strategically situated to hold and contain an explosive charge so that it can be detonated in the most efficient manner.

brine - strong saline solution.

C

carbon monoxide - a very toxic, colorless, odorless gas (CO) that burns to carbon dioxide and is formed as a product of the incomplete combustion of carbon.

carcinogen - a cancer-causing substance or agent.

chemical stimulant - a chemical substance that shares at least one characteristic of a chemical agent but with a reduced physiological effect.

chlorofluorocarbons (CFCs) - are nontoxic, nonflammable chemicals containing atoms of carbon, chlorine, and fluorine.

cholinesterase - an enzyme that hydrolyzes choline esters and that is found especially in blood plasma.

chronic - lasting for a long period of time or marked by frequent recurrence, as certain diseases.

colloidal clay - extremely fine, microscopic particles of rock.

conjunctivitis - pinkeye.

contamination-to make unfit for use by the introduction of unwholesome or undesirable elements.

corneal opacification - other disorders of the cornea that cause decreased visual function.

corrosivity - capable of corroding metal storage tanks or containers that may result in release of the material, or may injure persons who come in contact with it.

cutaneous - pertaining to the skin.

D

divalent compound - having a valence of two

draize test - application of any material or substance to the eye of an animal.

dry composition - the distance in the line of advance of a wave from any one point to the next point of corresponding phase.

dysprosium - an element that forms highly magnetic compounds.

E

ecosystem - a complex, self-sustaining natural system that includes living and non-living components of the environment and the circulation of matter and energy between organisms and their environment.

ecotoxicity - is the study of how chemicals affect the environment and the organisms living in it.

edema - watery swelling of plant organs

electrodialysis - the rapid removal of undesired ions from solution by the application of a direct current to electrodes inserted into a dialysis system.

emissions - substances discharged into the air (e.g. a smokestack, automobile gasoline engine).

endemic - native to or confined to a certain region.

endocarditis - inflammation of the lining of the heart and its valves

endocrine system - a collection of glands that produce hormones that regulate your body's growth, metabolism, and sexual development and function.

energetics testing - testing done to enhance the explosive power of weapons.

ephemeral - lasting for a very short time.

erythrocyte - red blood cell.

escarpment - a steep slope or long cliff that results from erosion or faulting and separates two relatively level areas of differing elevations.

etiology - the cause or origin of disease.

evaporation rates - the rate at which liquid water is transformed into a gaseous state.

evapotranspiration - a combination of evaporation from open bodies of water, evaporation from soil surfaces, and transpiration from the soil by plants.

F

ferro-magnesium - minerals cont-aining iron and magnesium

fibrosis - a condition marked by increase of interstitial fibrous tissue

fragmentation - process to break up into fragments

frostbite - frozen body tissue caused by prolonged cold exposure

functional group - an atom or group of atoms, such as a carboxyl group, that replaces hydrogen in an organic compound and that defines the structure of a family of compounds and determines the properties of the family.

G

gastrointestinal - affecting, or including both stomach and intestine

glutathione - a polypeptide of glycine, cystine, and glutamic acid that occurs widely in plant and animal tissues and is important in biological oxidation-reduction reactions.

glycoprotein - Any of a group of conjugated proteins that contain a carbohydrate as the nonprotein component.

H

half-life - the time required for half the amount of a substance (as a drug or radioactive tracer) in or introduced into a living system or ecosystem to be eliminated or disintegrated by natural processes

hemolysis - lysis of erythrocytes with the release of hemoglobin.

Henry's Law - is found to be an accurate description of the behavior of gases dissolving in liquids when concentrations and partial pressures are reasonably low.

hydrocarbon - an organic compound containing only carbon and hydrogen often occurring in petroleum, natural gas, and coal.

hydrolysis - a chemical decomposition practice involving the breaking of a bond and the addition of the hydrogen cation and the hydroxide.

hydrophobic - repelling, tending not to combine with, or incapable of dissolving in water.

hygroscopic - adsorbs moisture.

hyperphosphatemia - caused by increased absorption, decreased loss (renal failure) or increased production (cell destruction).

hypoactive - abnormally inactive.

hypocalcemia - lack of calcium in the blood.

hypoglycaemia - abnormal decrease of sugar in the blood.

hypopyon - layering out of white blood cells in anterior chamber .

I

igneous rock - called fire rocks and are formed either underground or above ground.

inert - not readily reactive with other elements; forming few or no chemical compounds.

Immediately Dangerous to Life and Health (IDLH) - These values are used to determine the appropriate respirators for hazardous chemicals. These values stand for the maximum concentration from which a worker could escape within 30 minutes without any escape-impairing symptoms or irreversible health effects in the event of a respirator failure.

inoculum - the introduction of a pathogen or antigen into a living organism to stimulate the production of antibodies

insectivorous – feeding on insects.

influenza - an acute contagious viral infection characterized by inflammation of the respiratory tract and by fever, chills, and muscular pain.

intrauterine - occurring within the uterus.

intraperitoneal - administered by entering the peritoneum.

intravenous - entering by way of a vein.

intrusive - an artifact or feature found within a feature, component or stratum of which it was not originally a part.

ion-exchange - a process in which ions are exchanged between a solution and an insoluble solid.

K

K_{oc} – is the ratio of the amount of the substance adsorbed per unit weight of organic carbon in the soil to the concentration of the substance remaining in the water at equilibrium.

keratitis - inflammation of the cornea of the eye.

L

Lethal Concentration (LC_{50}) - a chemical concentration that is lethal to fifty percent of a test population.

Lethal Concentration Low (LC-LO) - This value indicates the lowest concentration of a substance in air that caused death in humans or laboratory animals. The value may represent periods of exposure that are less than 24 hours(acute) or greater than 24 hours (subacute and chronic).

LD_{50} - a chemical dose lethal to fifty percent of a test population.

Lethal Dose Low (LD-LO) - The lowest dose, other than inhalation, that caused death in humans or animals.

LD_{100} - Lowest concentration of a substance in an environmental medium which kills 100% of test organisms or species under defined conditions. This value is dependent on the number of organisms used in its assessment.

lethality - the quality or condition of causing death.

lethargic - not very alert or active.

leucopenia - an abnormal lowering of the white blood cell count.

M

maximum contaminant level-(MCL) - maximum level of a contaminant allowed in water by Federal law. Based on health effects and currently available treatment methods.

median effective concentration (EC_{50}) – it represents the plasma concentration /AUC required for obtaining 50 % of the maximum effect *in vivo*

metabolite - a product of metabolism.

metamorphism - the process of changing the characteristics of a rock in response to changes in temperature, pressure, or volatile content.

methemoglobinemia - presence of methemoglobin in the blood.

milligrams per cubic meter of air, (mg/m^3) - This unit of measuring concentrations of particulate (minute dust-like particles).

monomer - a simple molecular unit where a polymer can be made.

monovalent compound - having a valence of one.

N

nanocrystalline materials - are polycryalline materials with grain size of up to 100 nm.

National Fire Protection Association, (NFPA) - This group of fire protection personnel established a rating system used on many labels of hazardous materials. The label consist of a diamond divided into four sections. The sections represent the following categories: Health, Flammability, Reactivity, Special precautions.

National Institute of Occupational Safety and Health (NIOSH) - This agency of the Public Health Service test and certifies respiratory and air-sampling devices. It recommends to OSHA exposure limits for hazardous substances. It also investigates incidents and researches occupational safety.

neonatal - affecting the newborn and especially the human infant during the first month after birth

neural system - nervous system.

nitrogen - a colorless tasteless odorless element; as a diatomic gas, it constitutes 78 percent of the atmosphere by volume and occurs as a constituent of all living tissues.

nitrogen dioxide - a toxic reddish brown gas (NO_2) and an air pollutant. It is produced by burning of fossil fuels.

non-ionizing radiation - lower energy electromagnetic radiation, mostly in microwave and thermal wavelengths.

nutrification - excessive application of fertilizers to soil and water.

O

obscurant - smoke, particulate matter, fiber or other material used directly on or near the enemy with the primary purpose of suppressing observers and minimizing the enemy's vision both within and beyond their position area.

occupational exposure - exposure received during work or related occupation.

ochric - epipedons that are too light in color, too low in organic carbon, or too thin to belong to mollic, umbric, anthropic, plaggen, or histic epipedons.

opacification - the process of becoming cloudy or opaque.

ophthalmology - branch of medical science dealing with the structure, functions, and diseases of the eye.

osteomalacia - a disease of adults that is characterized by softening of the bones and is analogous to rickets in the immature

oxidizer - a chemical which supplies its own oxygen and which helps other combustible material burn more readily.

oxygen - deficiency-lack of oxygen

ozone - a very reactive form of oxygen that is formed naturally in the atmosphere by a photochemical reaction. It is a major air pollutant in the lower atmosphere but a beneficial component of the upper atmosphere.

P

parameter - one of a set of variables that can be measured quantitatively, such as temperature or pressure, that define a system.

particulates – particulate matter (PM) is a mixture of solid particles and liquid droplets in the air. These particles originate from both stationary and mobile sources and also from natural sources.

parts per million (ppm) - This is a common unit of concentration of gas or vapor in air expressed with many exposure limits. It is defined as parts of gas or vapor per million parts of air by volume at 25 degrees C and 1 atm of pressure.

pathogenic - capable of causing disease.

periodontal - a disease that attacks the gum and bone and around the teeth.

peritoneum - the smooth transparent serous membrane that lines the cavity of the abdomen of a mammal and is folded inward over the abdominal and pelvic viscera.

permissible exposure limit (PEL) - This is one of the most important OSHA limits used. It is defined as the allowable limit for air contaminant in which workers may be exposed day after day without adverse health effects.

photo-degradation - that will decompose under exposure to certain kinds of radiant energy, esp. ultraviolet light.

photolysis - chemical decomposition by the action of radiant energy.

photolytic - chemical degradation composition by the action of radiant energy.

physiological - being in accord with or characteristic of the normal functioning of a living organism.

pneumoconiosis - disease of the lungs caused by the habitual inhalation of irritants.

polyalcohol - any alcohol that contains more than two hydroxyl groups. Glycerol is a polyol.

polycyclic organic matter (POM) - a group of chemicals produced by incomplete combustion.

polymer - a complex compound formed by the polymerization of one or more monomers.

polyvinyl chloride (PVC) - is a major thermoplastic material finding use in a very wide variety of applications and products

population - all the organisms that constitute a specific group or occur in a specified habitat.

precipitation - any form of water, such as rain, snow, sleet, or hail, that falls to the earth's surface.

precursor - a substance, cell, or cellular component from which another substance, cell, or cellular component is formed.

phytotoxic - poisonous to plants.

pyrophoric - a material that spontaneously ignites upon exposure to air.

pyrotechnic - a combustible substance used in a firework.

R

radiation - the process of emitting radiant energy in waves of particles.

recommended exposure limit (REL) - The highest allowable air concentration that will not injure a person.

respirable - able to be taken in by breathing.

rodenticide - kills, repels, or controls rodents

S

sedimentary rocks - are those rocks which form at or near the earth's surface at relatively low temperatures and pressures primarily.

Short-Term Exposure Limit (STEL) - The 15-minute time-weighted average exposure which must not be exceeded at any time during a work day.

silicosis - pneumoconiosis characterized by massive fibrosis of the lungs resulting in shortness of breath and caused by prolonged inhalation of silica dusts

simulant - see biological simulant and chemical simulant.

somnolence - being drowsy

spodic - a soil horizon that has been enriched with organic matter, iron, and aluminum from the overlying horizons.

subcutaneous - beneath the skin.

subchronic - usually used to describe studies or levels of exposure between 5 and 90 days.

sulfur dioxide - a heavy pungent toxic gas (SO_2) and an air pollutant. It condenses to a colorless liquid, is used especially in making sulfuric acid, in bleaching, as a preservative, and as a refrigerant.

T

taggant - materials used to track the path of simulant plumes through the air.

temporal - relating to measured time.

teratogenic - causing developmental malformations.

tetrasodium salt - used as a scale and corrosion agent for water-cooling circulation and water boilers.

thermal decomposition - is a chemical reaction where a single compound breaks up into two or more simpler compounds or elements when heated.

Threshold Limit Value (TLV) - The air concentration levels of hazardous substances to which workers may be repeatedly exposed day after day without adverse health effects.

Threshold Limit Value-Time-Weighted Average, (TLV-TWA) - Time-weighted average concentration for an 8-hour workday and a 40-hour work week in which a worker may be repeated exposed without adverse health effects.

Threshold Limit Value-Short-Term Exposure Limit, (TLV-STEL) - This is the maximum concentration which workers can be exposed for 15 minutes continuously without adverse health affects. Only four of these 15-minutes exposures are permitted per day and must have 60 minutes between

exposures.The TLV-TWA still must not be exceeded.

Time Weighted Average (TWA) - The workers average airborne exposure in any 8-hour work day of a 40 hour work week which should not be exceeded.

thrombocytopenia - low platelet count.

tinnitus - ringing of the ears.

Toxic Concentration Low, (TC-LO) - This is the lowest concentration of an airborne substance in which humans or animals have been exposed that resulted with any toxic effects in humans or produced any tumors or adverse reproductive effects in animals or humans.

Toxic Dose Low (TD-LO) - The lowest dose of a hazardous substance introduced by means other than inhalation over a given time period that has been reported to produce toxic effects in humans or produced any tumors or adverse reproductive effects in animals or humans.

toxicity - characteristic of hazardous wastes that are harmful or fatal when ingested or absorbed.

tracer - ammunition containing chemicals that mark the flight of projectiles by a trail of smoke or fire.

transitory - existing or lasting only a short time; short-lived or temporary.

translucent - allowing the passage of light.

trivalent compound - having a chemical valence of three.

troposphere - the lowest layer of the atmosphere located between the earth's surface to approximately 11 miles (17 kilometers) into the atmosphere.

tuberculosis - is primarily an illness of the respiratory system, and is spread by coughing and sneezing.

tumorigen - tumor forming.

U

ubiquitous - existing or being everywhere at the same time.

utilitarian - made to be primarily functional and practical, having minimal decoration.

V

vapor pressure - the pressure exerted by a vapor; often understood to mean saturated vapor pressure (the vapor pressure of a vapor in contact with its liquid form).

ventricular - related to ventricle.

volatile organic carbon (VOC) - an organic chemical which can easily dissipate or evaporate into the air.

volatilization - to cause to pass off in vapor.

W

wavelength - the distance in the line of advance of a wave from any one point to the next point of corresponding phase.

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APPENDIX G

EXPOSURE DATA FOR DTRA TEST MATERIALS

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Test Material EIS Entry	Agent Simulated	[1,2]Lethal Dose (LD_{50})/Lethal mg/kg	Route	[1,2]Occupational Exposure Level Value	Reference	[1,2]Carcinogenicity/Human Toxicity	Additional comments	Discussion of Material
Biological Simulants (Amount per test)								
Bacillus subtilis var. niger (formerly *Bacillus globigii*) (BG) (200 lbs)	*Bacillus anthracis*	75	Intraperitonal (mouse)	Non Pathogenic NF	OSHS MSDS	Not known/Eye, skin irritant	Nonpathogenic; Gram-positive bacterium; common soil bacteria; crop soil additive	F-5
Bacillus thuringiensis bacteriophage (5 lbs/test)	Not Applicable	>5000	Oral (Rat)	Not Applicable	OSHA MSDS	Not known/Eye, skin irritant	Used as biological simulant	F-8
Bacillus thuringiensis (BT) (68038-71-1) (200 lbs)	*Bacillus anthracis*	20000	Oral (Rat)	Non Pathogenic NF	OSHS MSDS	Unlikely to be carcinogen/Eye, skin irritant	Nonpathogenic; Gram-positive bacterium; used as an insecticide; produces toxin harmful to catepillars	F-8
Clostridium sporogenes (150 lbs)	*Clostridium botulinum*	Not Available	Not Applicable	Non Pathogenic Not Available	Not Applicable	Does not cause disease in humans	Nonpathogenic; Gram-positive bacterium; species in human and animal gut flora; common soil bacteria	F-10
Erwinia herbicola (Ec) (200 lbs/test)	*Yersinia pestis*	Not Available	Not Applicable	Nonpathogenic	Not Found	Not Found/Not Found		F-11
Lactic Dehydrogenase (LDH) (200 lbs)	botulinum toxin	TDLo 16000	subcutaneous (mouse)	Non Toxic	OSHA	Not a carcinogen / Not hazardous to humans	Nontoxic; enzyme present in human blood plasma; converts pyruvate to lactate; potential, if injected to cause allergic reaction	F-12
MS2 Bacteriophage (150 lbs)	smallpox	Non Pathogenic Not Available	Not Applicable	Non Pathogenic	Not Applicable	Does not cause disease in humans	Nonpathogenic; *Escherichia coli* bacteriophage	F-12
Noninfectious (killed) Influenza A Virus (150 lbs)	Ebola	Non pathogenic Not Available	Not Applicable	Non Pathogenic	Not Applicable	Does not cause disease in humans	Nonpathogenic; Killed influenza A virus used in flu vaccine manufacture; potential, if injected, to cause allergic reaction	F-13
Ovalbumin (CAS 9006-59-1)(200 lbs)	ricin toxin	24000	Oral (Mouse)	Non Toxic	Not Applicable	Not a carcinogen / Eye, skin, and respiratory irritant	Nontoxic; Egg whites; potential if injected to cause allergic reaction	F-14
Chemical Simulants (Amount per test)								
1, 3, 5 Trimethylbenzene (mesitylene) (CAS 108-67-8)(4000 gal)	For chemical evaporation	LC 24 mg/m^3/4 hour	Inhalation (Rat)	123 mg/m^3 8 hour TWA	ACGIH	Not carcinogenic/Respiratory, skin, eye irritant		F-15
Bis (2-ethylhexyl) hydrogen phosphite (Bis) (CAS 3658-48-8)(4000 gal)	Nerve agent	11900	Oral (Rat)	Not Found	MSDS	Not carcinogenic/Respiratory, skin, eye irritant		F-16
Diethyl malonate (CAS 105-53-3)(4000 gal)	Nerve agent	15000	Oral (Rat)	Not Found	OSHA MSDS	Not carcinogenic/Respiratory, skin, eye irritant		F-18
Diethyl phthalate (CAS 84-66-2)(4000 gal)	Nerve agent dispersal and evapoRation	8600	Oral (Rat)	5 mg/m^3 TLV	ACGIH MSDS	Not carcinogenic/Respiratory, skin, eye irritant		F-18
Dimethyl Methylphosphonate (DMMP) (CAS 756-79-6) (4000 gal)	G nerve agent simulant	8210	Oral (Rat)	Not Found	MSDS	Possible carcinogen / Eye, skin, and respiratory irritant	Listed as a Schedule 2B in CWC; must declare if use exceeds 1 mT/year	F-20

Test Material		[1,2]Lethal Dose (LD_{50})/Lethal		[1,2]Occupational Exposure Level		[1,2]Carcinogenicity/Human Toxicity	Additional comments	Discussion of Material
EIS Entry	Agent Simulated	mg/kg	Route	Value	Reference			
Dipropylene glycol monomethyl ether (DPM; DPGME) (CAS 34590-94-8) (4000 gal)	Nerve agent simulant	535	Oral (Rat)	100 mg/L 8 Hour TWA	OSHA MSDS	Not carcinogenic/Slight eye irritant	Decontaminate	F-22
Glyceryl tributyrate (CAS 60-01-5)(4000 gal)	Thickened chemical agents	3200	Oral (Rat)	Not Found	OSHA MSDS	Not carcinogenic/Slight eye irritant		F-23
Methyl salicylate (MeS) (CAS 119-36-8) (4000 gal)	Mustard simulant	887	Oral (Rat)	Not Found	MSDS	Not carcinogenic/Eye, skin, and respiratory irritant		F-24
Propionic acid (CAS 79-09-4)(4000 gal)	Decontaminant	2600	Oral (Rat)	30 mg/m^3 PEL	NIOSH	Not carcinogenic/Severe skin,eye,respiratory, and digestive irritation and burning.		F-26
Thiodiglycol (TDG) (CAS 111-48-8) (4000 gal)	Mustard simulant	6110	Oral (Rat)	Not Found	MSDS	Not carcinogenic/Eye, skin, and respiratory irritant	Listed as a Schedule 2B in CWC; must declare if use exceeds 1 mT/year; used in ink manufacture	F-27
Tributyl phosphate (CAS 126-73-8) (4000 gal)	Nerve agent simulant	3000	Oral (Rat)	5 mg/m^3 TWA	OSHA MSDS	Possible carcinogen / Eye, skin, and respiratory irritant	Toxic to aquatic organisms(LC50: 48hr for red killifish 68mg/L).	F-28
Triethyl Phosphate (TEP; TEPO) (CAS 78-40-0) (4000 gal)	Nerve agent stimulant	1165	Oral (Rat)	1 mg/m^3 TWA	OSHA	Not carcinogenic/Possible reproductive effects, cholinesterase inhibitor		F-29
Triethyl phosphite (TEPI) (CAS 122-52-1) (4000 gal)	Nerve agent simulant	1840	Oral (Rat)	Not Found	MSDS	Not carcinogenic/Eye skin, respiratory, and gastrointestinal irritant	Listed as a Schedule 3B in CWC; must declare if use exceeds 30 mT/year	F-31
Triisopropyl phosphate (CAS 513-02-0)(4000 gal)	Nerve agent	Not Found	Not Found	Not Found	Not Found	Not carcinogenic/Irritating to eyes, skin, and respRatory system.		F-31
Trimethyl phosphite (CAS 121-45-9)(4000 gal)	Nerve agent	1600	Oral (Rat)	10 mg/m^3 PEL	NIOSH	Not carcinogenic/Irritating to eyes, skin, and respRatory system, digestive system.		F-32
Tripropyl phosphate (CAS 513-08-6)(4000 gal)	Nerve agent	Not Found	Not Found	Not Found	MSDS	Not carcinogenic/Irritating to eyes, skin, and respRatory system, digestive system.		F-33

Radiological Simulants
(Amount per test)

Test Material		[1,2]Lethal Dose (LD_{50})/Lethal		[1,2]Occupational Exposure Level		[1,2]Carcinogenicity/Human Toxicity		Discussion of Material
EIS Entry	**Agent Simulated**	**mg/kg**	**Route**	**Value**	**Reference**		**Additional comments**	
Cerium dioxide (CeO_2) (CAS 1306-38-3) (5kg)	Actinide simulant	>5000	Oral (Rat)	Not Found	OSHA MSDS	Not carcinogenic/Eye, skin, respiratory, digestive irritation.	Non-radioactive lanthinide; UO2 simulant; Simulant is not for use on a currently planned test. Sandia National Laboratories (SNL) supports DTRA with small scale tests using this simulant. Testing may be directed by DTRA, DoD or other government agencies as a follow-on to the DISCRETE FURY tests conducted at NTS in FY03. Testing at WSMR provides a more convenient location for test team members at SNL and LANL, and the TD Directorate Test and Technology Support Division (TDT) scientists and test coordinators.	F-35
Cesium chloride (CsCl) (CAS 7647-17-8) (5kg)	Cs-137 simulant	2600	Oral (Rat)	15 mg/m^3 Total dust PEL	OSHA MSDS	Not carcinogenic/Eye, skin, respiratory, digestive irritation.	Non-radioactive version; Simulant is not for use on a currently planned test. SNL supports DTRA with small scale tests using this simulant. Testing may be directed by DTRA, DoD or other government agencies as a follow-on to the DISCRETE FURY tests conducted at NTS in FY03. Testing at WSMR provides a more convenient location for test team members at SNL and LANL, and the TDT scientists and test coordinators.	F-35
Manganese dioxide (MnO_2) (CAS 1313-13-9) (5kg)	Co-60 simulant	422	Oral (mouse)	5 mg/m^3 PEL	OSHA MSDS	Not carcinogenic/Eye, skin, respiratory, digestive irritation.	Non-radioactive version; Simulant is not for use on a currently planned test. SNL supports DTRA with small scale tests using	F-36
Strontium titanate (SrTiO3) (CAS 12060-59-2) (5kg)	Sr-90 simulant	Not Found	Not Found	0.5 mg/m^3 PEL	OSHA MSDS	Not carcinogenic/Eye, skin, respiratory, irritation.	this simulant. Simulant was used previously on an unplanned testing effort (DISCRETE	F-37

Tracers and Taggants
(Amount per test)

BAS-Oil Red Dye (20 gal)	Dye, plume taggant	1400	Oral (Rat)	5 mg/m^3 8 hour (mist) PEL	MSDS	Not a carcinogen / minor eye, skin, and respiratory irritant	Oil-based herbicide formulation	F-39
Carbon Tetrafluoride (CF_4) (CAS 75-73-0) (150 lbs)	Plume tracer	LC 895000 ppm	Inhalation (Rat)	10 mg/m^3 8Hr/40H PEL	OSHA MSDS	Possible carcinogen/Skin irritant; could cause nausea, vomiting, disorientation, suffocation	Used as a low temperature refrigerant and gaseous insulator	F-39
2-Diethylamino ethanethiol (CAS 1942-52-5) (400 gal/test)	Not Applicable	100	Intraperitoneal (Mouse)	Not Found	Not Found	Possible caricnogen/Eye, skin, respiratory irritant, Ingestion of large amounts may cause gastrointestinal irritation		F-40
2-Diisopropylamino ethanethiol (CAS 41480-75-5) (400 gal/test)	Not Applicable	Not Found	Not Found	Not Found	Not Found	Possible carcinogen/Eye, skin, respiratory irritant.	Listed as a Schedule 2B in CWC; must declare if use exceeds 1 mT/year	F-41

Test Material EIS Entry	Agent Simulated	[1,2]Lethal Dose (LD_{50})/Lethal mg/kg	Route	[1,2]Occupational Exposure Level Value	Reference	[1,2]Carcinogenicity/Human Toxicity	Additional comments	Discussion of Material
Dysprosium Oxide (CAS 1308-87-8) (100 lbs)	Plume tracer	>5000	Oral (Rat)	Not Found	OSHA	Not carcinogenic/May cause eye, skin, respiratory, and digestive tract irritation	Used in nuclear reactor control rods	F-42
Fluorescein (CAS 2321-07-5) (110 lbs/test)	Not Applicable	300	Intravenous (Mouse)	Not Found	OSHA MSDS	Not carcinogenic/Eye, skin, digestive, and respiratory tract irritant		F-43
Forane 134A (1,1,1,2-tetrafluoroethane) (CAS 811-97-2) (100 lbs)	Plume tracer	1500 gm/m^3/4 hour	Oral (Rat)	Not Found	OSHA MSDS	Not carcinogenic/Slight eye and skin irritant; inhalation may cause dizziness, drowsiness, rapid heartbeat, suffocation	Refrigerant, foaming agent	F-43
Indium Oxide (CAS 1312-43-2) (100 lbs)	Plume tracer	10	Oral (Rat)	Not Found	OSHA	Not a carcinogen/Eye, skin, mucous membrane, and respiratory irritant		F-44
Locate Blue Liquid Dye (40 gal)	Dye, plume taggant	5	Oral (Rat)	Not Found	MSDS	Not a carcinogen /Minor eye, skin, and respiratory irritant		F-46
Malachite green (CAS 633-03-4) (110 lbs/test)	Not Applicable	10 LDLo	Oral (Rat)	Not Found	OSHA MSDS	Not carcinogenic/Eye, skin, respiratory, digestive tract irritant	LDLo- Lowest published lethal dose	F-48
Pentafluoroethane (PFE; Halocarbon 125; Zyron 125) (CAS 354-33-6) (250 lbs/test)	**Not Applicable**	LC50 2910 g/m^3/4 hr	Inhalation (Rat)	1000 ppm TWA (8 hr)	AIHA	Not a carcinogen/Skin, eye, and respiratory irritant, can impair CNS.	Potential SF_6 replacement	F-49
Scandium Oxide (CAS 12060-08-1) (100 lbs)	Not Applicable	Not Found	Not Found	15 mg/m^3 PEL	OSHA MSDS	Not a carcinogen/ Skin,eye,respiratory irritant		F-50
Sulfur hexafluoride(SF6) (CAS 2551-62-4) (250 lbs)	Plume tracer	5790	Oral (Rat)	6000 mg/m^3 PEL	OSHA MSDS	Not a carcinogen / Could displace oxygen and cause suffocation		F-51

Interferents
(Amount per test)

Bleach (55 Gal)	Smoke interferent	5800	Oral (Mouse)	0.5 ppm PEL	OSHA MSDS	Not carcinogenic/Moderate to severe eye, skin, and respiratory irritant	Oxidizer	F-55
Burning butyl rubber (burning organics) (increase from 4 to 12 large tires)	Smoke interferent	Not Found	Not Found	15 mg/m^3 Total Dust PEL	OSHA MSDS	Not a carcinogen/Eye, skin, mucous membrane, and respiratory irritant	Smoke interferent	F-56
Burning Kerosene or diesel fuel (combustion products) (100 gal)	Smoke interferent	>5000	Oral (Rat)	100 mg/L PEL	OSHA MSDS	Possible carcinogen/Moderate to severe eye, skin, and respiratory irritant	Smoke interferent, LD & PEL based on kerosene	F-57
Burning Plastic (burning organics) (15 lbs)	Smoke interferent	1243	Skin (Rabbit)	35 mg/m^3 TWA	OSHA MSDS	Not a carcinogen/Eye, skin, mucous membrane, and respiratory irritant	Smoke interferent, Based on methyl methacrylate as plastic.	F-56
Burning Wood (burning organics) (100 lbs)	Smoke interferent	Not Found	Not Found	15 mg/m^3 Total Dust PEL	OSHA MSDS	Not carcinogenic/Eye, skin, ingestion, and respiratory irriatant	Smoke interferent	F-56

Other Test Material

Test Material EIS Entry	Agent Simulated	[1,2]Lethal Dose (LD_{50})/Lethal mg/kg	Route	[1,2]Occupational Exposure Level Value	Reference	[1,2]Carcinogenicity/Human Toxicity	Additional comments	Discussion of Material
(Amount per test)								
Bentonite Clay (CAS 1302-78-9) (100 lbs/test)	Inert filter/dust	35	Intravenous (Rat)	0.1 mg/m^3 PEL	OSHA	Not a carcinogen/Eye, skin, respiratory irritation	Used for capping wells, inert filter/dust	F-59
Kaolin (600 lbs) (CAS 1332-58-7)	Not Applicable	TDLo 590000	Oral (Rat)	15 mg/m^3 PEL	OSHA MSDS	Not a carcinogen/Eye, skin, and respiratory irritant	Inert dust, Thickener	F-60
Luria Broth (LB) (55 lbs/test)	Not Applicable	3000	Oral (Rat)	Not Found	OSHA MSDS	Not carcinogenic/irritant on skin	Used for live simulant testing, LD PEL based on NaCl	F-61
Magnesium chloride (250,000 lbs) (CAS 7786-30-3)	Not Applicable	4700	Oral (Mouse)	Not Found	OSHA	Not carcinogenic/Eye, skin, respiratory, and gastrointestinal irritant	Dust suppressant	F-61
Oleoresin capsicum (10 lbs) (CAS 404-86-4)	Not Applicable	1.1	Unknown (Guinea Pig)	Not Found	MSDS	Not carcinogenic/Eye, respiratory and skin irritant.		F-62
Phenol (22 lbs) (CAS 108-95-2)	Not Applicable	317	Oral (Rat)	19 mg/m^3 TWA	OSHA	Not a carcinogen /Skin and respiratory irritant, may cause severe eye damage	Preservative	F-63
Polymethyl Methacrylate (PMMA) (2300 lbs) (CAS 9011-14-7)	Not Applicable	>50000	Oral (Rat)	Not Found	OSHA MSDS	Carcinogen/Eye, skin, and respiratory irritant	Thickener	F-65
Polystyrene (CAS 9003-53-6) (25 lbs/test)	Not Applicable	TDLo 200 /2W-I	Intravenous (Rat)	10 mg/m^3 Inspirable Dust PEL	NOHSC MSDS	Not a carcinogen/Skin and eye irritation. May be harmful if inhaled or ingested.	Test instrument component	F-67
Polystyrene-Butylmethacrylate (PSBA) (2300 lbs)	Not Applicable	19 (PS)/1600 (BA)	Implant (Rat)(PS)/Oral (Rat) (BA)	Not Found	Not Found	Not carcinogenic/Eye, skin, and respiratory irritant	Thickener, LD based on separate ingredients	F-67
Sand (silica) (CAS 14808-60-7) (25 lbs/test)	Inert filter/dust	LCLo 0.3 mg/m3	Inhalation (human)	30 mg/m^3 PEL	OSHA	Possible carcinogen/respiratory, eye, skin irritant	Inert filter/dust	F-68
Silicon (CAS 7440-21-3) (5 lbs/test)	Not Applicable	3160	Oral (Rat)	15 mg/m^3 (Total Dust) TWA	OSHA MSDS	Carcinogen/Severe irritation and burning in eyes, skin, respiratory, digestive system and other health problems.	Test instrument component	F-69
Smokecloak FL 600 Fluid (3 gal)	Not Applicable	21000-33700	Oral (Rat)	OES for monopropylene glycol 150 ppm (total vapor), 10 mg/m3 (particulates for 15-minutes STEL)	MSDS	Not carcinogenic/May cause slight irritation to skin, eyes, and mucous membranes. Large doses may produce adverse effects on liver, kidneys, and CNS.		F-70
Sticky Foam (1200 lbs) (CAS No. None) (Chlorodifluoromethane -)	Not Applicable	> 43200 ug/kg (chlorodifluoromethane)	Inhalation (Rat) (chlorodifluoromethane)	1000 ppm (Chlorodifluoromethane) TWA	OSHA MSDS (Chlorodifluoromethane)	Not a carcinogen/Eye, skin, respiratory and digestive irritant. It can cause asphyxiation. (Chlorodifluoromethane)		F-71
Tergitol 15-S-9 Nonionic (20 lbs) (CAS 68131-40-8)	Not Applicable	3360 ul/kg	Oral (Rat)	Not Found	Not Found	Not carcinogenic/Eye, skin, and respiratory irritant	surfactant	F-73

High Explosives
(Amount per test)

Test Material		[1,2]Lethal Dose (LD_{50})/Lethal		[1,2]Occupational Exposure Level		[1,2]Carcinogenicity/Human		
EIS Entry	Agent Simulated	mg/kg	Route	Value	Reference	Toxicity	Additional comments	Discussion of Material
AFX-757 (20,000 lbs)	Not Applicable	4200(Al)	Oral (Rat) (Al)	15 mg/m^3 (ClH_4NO_4) PEL	OSHA (ClH_4NO_4)	Not a carcinogen/Irritant to respiratory,skin, eye (Al).Carcinogen/Irritantant to respiratory/skin, eye (ClH4NO4)	LD & PEL based on individual explosive components	F-75
AFX-777 (2500 lbs)	Not Applicable	4200 (Al)	Oral (Rat) (Al)	15 mg/m^3 (ClH_4NO_4) PEL	OSHA (ClH_4NO_4)	Carcinogen/Eye, skin, respiratory irritant. Pulmonary fibriosis has been reported due to prolonged exposure (Al). Carcinogen/Mild irritant to the eyes, skin, digestive tract and mucous membrane (ClH4NO4).	LD & PEL based on individual explosive components	F-75
Ammonium nitrate-fuel oil (ANFO) (500 Ton TNT equivalent)	Explosive	2217-AN/14.5 ml/kg-FO	Oral (Rat)- AN & FO	5 mg/m^3 as mineral oil (FO) TWA/NE-AN	OSHA (FO) MSDS OSHA-AN	Not carcinogenic/Eye, skin, and respiratory irritant	LD50 based on individual chemicals (AN-FO) FO based on NO. 2 fuel oil	F-75
APHAS-4 (2500 lbs)	Not Applicable	Not Found	Not Found	Not Found	Not Found	Not Found/Not Found		F-77
Composition 4 (C-4) (91% RDX; 9% plasticizer) (2 tons) (CAS 121-82-4)	Explosive	100	Oral (Rat)	1.5 mg/m^3 PEL	OSHA MSDS	Not carcinogenic/Eye, skin, and respiratory irritant	LD & PEL based on (C-4)	F-77
Cyclotetramethylenetetranitramine (HMX) (1 ton) (CAS 2691-41-0)	Explosive	300	Oral (Guinea pig)	Not Found	OSHA MSDS	Not carcinogenic/Eye, skin, and respiratory irritant		F-79
Cyclotrimethylenetrinitramine (RDX) (1 ton) (CAS 121-82-4)	Explosive	100	Oral (Rat)	1.5 mg/m^3 PEL	OSHA MSDS	Not carcinogenic/Eye, skin, and respiratory irritant		F-77
Emulsion Explosives Iregel-82, Iremite-62, QM-100, QM-100R (23 tons)	Explosive	a. 2217 b. 1267	Oral (Rat)	Not Found	MSDS	Not carcinogenic/Eye, skin, and respiratory irritant; may cause serious pulmonary symptoms.	Explosive mixture animal toxicity based on: a. if ammonium nitrate is an ingredient b. if sodium nitrate is an ingredient	F-80
GSI-0005 (2500 lbs)	Not Applicable	2660-BA 1530 PA	Oral (Rat)-BA & PA	1 mg/m^3-PA 8Hr. TWA	OSHA MSDS	Carcinogen/Extreme eye, skin, and respiratory irritant (BA & PA)	LD & PEL from Boric Acid (BA) & Phosphoric Acid	F-81-82
GSI-0018 (2500 lbs)	Not Applicable	2660-BA 1530 PA	Oral (Rat)-BA & PA	1 mg/m^3-PA 8Hr. TWA	OSHA MSDS	Carcinogen/Extreme eye, skin, and respiratory irritant (BA & PA)	LD & PEL from Boric Acid (BA) & Phosphoric Acid	F-81-82
HAS-4 (2500 lbs)	Not Applicable	Not Found	Not Found	Not Found	Not Found	Not Found/Not Found		F-83
HAS-12 (2500 lbs)	Not Applicable	300 (HMX)/4200 (Al)	Oral (Guinea pig) HMX Oral (Rat) (Al)	Not Found	Not Found	Carcinogen/Eye, skin, respiratory irritant. Pulmonary fibriosis has been reported due to prolonged exposure (Al).	LD basesd on individual HMX, AL, binder no known	F-84
MAC-112 (2500 lbs)	Not Applicable	Not Found	Not Found	Not Found	Not Found	Not Found/Not Found		F-84
Nitromethane (NM) (20 tons) (CAS 75-52-5)	Explosive	940	Oral (Rat)	100 ppm TWA	OSHA MSDS	Possible carcinogen/Eye, skin, and respiratory irritant; may cause nausea, headaches		F-82
PBXC-133 (2500 lbs)	Not Applicable	300 (HMX)	Oral (Guinea pig) HMX	Not Found	Not Found	Not a carcinogen/Eye, skin, and respiratory irritant	LD based on individual HMX	F-85

Test Material		[1,2]Lethal Dose (LD_{50})/Lethal		[1,2]Occupational Exposure Level		[1,2]Carcinogenicity/Human		Discussion of
EIS Entry	Agent Simulated	mg/kg	Route	Value	Reference	Toxicity	Additional comments	Material
PBXIH-135 (2500 lbs)	Not Applicable	100 (RDX)	Oral (Rat) (RDX)	1.5 mg/m^3 (RDX) PEL	OSHA (RDX)	Not a carcinogen/irritant to respiratory, skin, eye (RDX).	LD & PEL based on individual RDX	F-85
PBXIH-136 (2500 lbs)	Not Applicable	100 (RDX)	Oral (Rat) (RDX)	1.5 mg/m^3 (RDX) PEL	OSHA (RDX)	Not a carcinogen/Eye, skin, and respiratory irritant	LD & PEL based on individual RDX	F-85
PBXN-103 (2500 lbs)	Not Applicable	100 (RDX)	Oral (Rat) (RDX)	1.5 mg/m^3 (RDX) PEL	OSHA (RDX)	Not a carcinogen/Eye, skin, and respiratory irritant	LD & PEL based on individual RDX	F-85
PBXN-109 (2500 lbs)	Not Applicable	100 (RDX)	Oral (Rat) (RDX)	1.5 mg/m^3 (RDX) PEL	OSHA (RDX)	Not a carcinogen/Eye, skin, and respiratory irritant	LD & PEL based on individual RDX	F-85
PBXN-111 (2500 lbs)	Not Applicable	100 (RDX)	Oral (Rat) (RDX)	1.5 mg/m^3 (RDX) PEL	OSHA (RDX)	Not a carcinogen/ Eye, skin, and respiratory irritant	LD & PEL based on individual RDX	F-85
PBXW-128 (2500 lbs)	Not Applicable	300 (HMX)	Oral (Guinea pig) HMX	Not Found	Not Found	Not a carcinogen/ Eye, skin, and respiratory irritant	LD based on individual HMX	F-85
Pentaerythritol tetranitrate (PETN) (1000 lbs) (CAS 78-11-5)	Explosive	100000	Oral (Rat)	1500 mg/m^3	OSHA MSDS	Not a carcinogen/Eye, skin, and respiratory irritant; may cause nausea, headaches, dizziness, weakness		F-86
Pentolite (1000 lbs) (CAS 8066-33-9)	Explosive	>100000 (PETN) 600 (TNT)	Oral (Rat, Mice)	1.5 mg/m^3 (TNT) PEL/NE (PETN)	OSHA MSDS	Not Applicable/Not Applicable	Pentolite- (PETN/TNT) LD50 & PEL based on separate ingredients	F-87
Red Phosphorus (CAS 7723-14-0)(2500 lbs)	Not Applicable	4412 ug/kg	LDLo Unreported (Human)	0.1 mg/m^3 TWA	OSHA	Not a carcinogen/Severe skin, eye, and respiratory irritant and may cause severe damage		F-87
Trinitrotoluene (TNT) (500 lbs) (CAS 118-96-7)	Explosive	660	Oral (Mice)	1.5 mg/m3 PEL	OSHA MSDS	Possible carcinogen/Eye, skin, respiratory irritant; may cause nausea, dizziness, weakness, confusion		F-89
Tritonal (increase limit from 1000 lbs to 20,000 lbs)	Explosive	660 (TNT) 200 (AL)	Oral (Mice) Implant (Rat)	1.5 mg/m^3 (TNT) PEL/ 15 mg/m^3 Total Dust PEL	OSHA MSDS	Not Applicable/Not Applicable	Tritonal (TNT/Al)	F-90
White Phosphorus (CAS 7723-14-0) (2500 lbs)	Not Applicable	3030 ug/kg	LDLo Oral (human)	0.1 mg/m^3 TWA	OSHA	Not a carcinogen/Severe skin, eye, and respiratory irritant and may cause severe damage		F-87

Energetic/Reactive Materials

Aluminum (CAS 7429-90-5)	Not Applicable	1260	Oral (mouse)	15 mg/m^3 TWA	OSHA MSDS	Not a carcinogen/Eye, skin, respiratory irritant. Pulmonary fibriosis has been reported due to prolonged exposure	Rocket propellant	F-95
Ammonium Nitrate (CAS 6484-52-2)	Not Applicable	2217	Oral (Rat)	Not Found	MSDS	Not a carcinogen/Eye, skin, respiratory and digestive system.Inhalation of large amouts causes acidiosis and abnormal hemoglobin.	Oxidizer	F-97

Test Material		[1,2]Lethal Dose (LD_{50})/Lethal		[1,2]Occupational Exposure Level		[1,2]Carcinogenicity/Human		Discussion of
EIS Entry	Agent Simulated	mg/kg	Route	Value	Reference	Toxicity	Additional comments	Material
Ammonium Perchlorate (CAS 7790-98-9)	Not Applicable	4200	Oral (Rat)	Not Found	MSDS	Not a carcinogen/Mild eye, skin, respiratory and digestive irritant.Chronic intake of perchlorate ion may have a reversible effect on the thyroid gland.	Oxidizer	F-98
Boron (CAS 7440-42-8)	Not Applicable	2660	Oral (Rat)	Not Found	MSDS	Not a carcinogen/Eye, skin, respiratory irritant	Ignition source	F-98
Hexachloroethane (CAS 67-72-1)	Not Applicable	4460	Oral (Rat)	10 mg/m^3 TWA	OSHA MSDS	Possible carcinogen/Eye, skin, respiratory irritant.ingestion causes CNS, liver, and kidney damage.		F-100
Isopropyl nitrate (IPN) (CAS 1712-64-7)	Not Applicable	LC 50 29 gm/32 hours	Inhalation (Rat)	Not Found	MSDS	Not a carcinogen/Severe eye, skin, respiratory, and digestive system irritant. May cause permanent corneal opacification, cyanosis of the extremities..		F-101
Magnesium (CAS 7439-95-4)	Not Applicable	Not Found	Not Found	15 mg/m^3 TWA	OSHA	Not a carcinogen/Eye, skin, and respiratory irritant		F-102
Potassium Perchlorate (CAS 7778-74-7)	Not Applicable	2100	Oral (Rat)	15 mg/m^3 (Total Dust) PEL	OSHA MSDS	Possible carcinogen/Severe eye, skin, respiratory, and digestive irritant.	Oxidizer	F-103
Sodium Perchlorate (CAS 7601-89-0)	Not Applicable	2100	Oral (Rat)	Not Found	MSDS	Possible carcinogen/Eye, skin, respiratory, and digestive irritant. may cause thyroid inhibition, methemoglobinemia, cyanosis.		F-103
Teflon Polymer (Viton, Teflon) (PTFE)(CAS 9002-84-0)	Not Applicable	80 TDLo	Implant (Rat)	Not Found	MSDS	Not a carcinogen/Eye, skin, respiratory irritant.	LD & PEL based on active ingredient-PTFE	F-104
Titanium (CAS 7440-32-6)	Not Applicable	360 mg/kg 69W-I	Intramuscular (Rat)	10 mg/m^3 as TiO_2 for Total Dust PEL	OSHA MSDS	Possible carcinogen/Eye, skin, respiratory, and digestive irritant.	Oxidizer	F-104

Rocket Propellants

Ammonium Perchlorate/Aluminum/ binder propellants (AP/Al)	Not Applicable	4200 AP NK AL	Oral (Rat) AP NK Al	NF AP/15 mg/m^3 TWA Al	MSDS AP OSHA Al	Carcinogen/Mild eye, skin, respiratory and digestive irritant.Chronic intake of perchlorate ion may have a reversible effect on the thyroid gland (AP)/Carcinogen/Eye, skin, respiratory irritant.Pulmonary fibriosis has been reported due to prolonged exposure (Al).	AP- Ammonium Perchlorate, Al-Aluminum	F-107
Inhibited Red Fuming Nitric Acid (IRFNA) (CAS 7697-37-2)	Not Applicable	430	Oral (Human)	5 mg/m^3 PEL	OSHA MSDS	Possible carcinogen/Eye, skin, respiratory irritant	HF (trace amt.) added to IRFNA as a corrosive inhibitor.	F-107

Test Material EIS Entry	Agent Simulated	[1,2]Lethal Dose (LD_{50})/Lethal mg/kg	Route	[1,2]Occupational Exposure Level Value	Reference	[1,2]Carcinogenicity/Human Toxicity	Additional comments	Discussion of Material
Nitrate Ester propellants (Nitroglycerin - NG & Nitrocellulose - NC)	Not Applicable	105 (NG) 5000 (NC)	Oral (Rat)- (NC & NG)	2 mg/m^3 (NG) PEL/NK (NC)	OSHA MSDS	Not carcinogenic/Eye, skin, respiratory and digestive system irritant (NG). Not caricnogenic/Eye, skin, respiratory and digestive system irritant (NC).		F-109-110
Triamino-trinitrobenzene TATB (CAS 3058-38-6)	Not Applicable	>5000	Oral (Rat)	Not Found	MSDS	Not carcinogenic/Mild eye, skin, respiratory and digestive system irritant		F-110
Unsymmetrical Dimethyl Hydrazine (UDMH) (CAS 57-14-7)	Not Applicable	122	Oral (Rat)	1 mg/m^3 PEL	OSHA MSDS	Possible carcinogen/Causes eye and skin burns. May cause severe/permanent damage to the digestive tract and respiratory system.	Stablizer for organic peroxide fuel additives, plant control agent	F-111

Non-Energetic Test Materials

Test Material EIS Entry	Agent Simulated	mg/kg	Route	Value	Reference	Carcinogenicity/Human Toxicity	Additional comments	Discussion of Material
Alumina (aluminum oxide) (CAS 1344-28-1) (600 lbs)	Plume taggant	200	Implant (Rat)	15 mg/m^3 Total Dust PEL	OSHA	Not a carcinogen / minor eye, skin, and respiratory irritant	Explosive additive	F-114
Benzyl mercaptan (CAS 100-53-8)	Not Applicable	493	Oral (Rat)	Not Found	OSHA MSDS	Not a carcinogen/Eye, skin, digestive, and respiratory irritant		F-115
Boron trifluoride (BF_3)(CAS 7637-07-2)	Not Applicable	>1000 ppm/3Hr	Inhalation (Dog)	3 mg/m^3 PEL	OSHA MSDS	Not Available/ Causes eye, skin, and respiratory burns.		F-116
Bromine (CAS 7726-95-6)	Not Applicable	2600	Oral (Rat)	0.1 ppm PEL	OSHA MSDS	Not a carcinogen/Both liquid and vapor are corrosive to all body tissues and may cause serious burns. Estimated lethal dose if ingested 14 mg/kg.		F-118
Bromine Trifluoride (BrF_3) (CAS 7787-71-5)	Not Applicable	Not Found	Not Found	2.5 mg/m^3 TWA	OSHA MSDS	Not a carcinogen/respiratory tract burns, skin burns, eye burns, mucous membrane burns		F-119
Butyl mercaptan (CAS 109-79-5)	Not Applicable	1500	Oral (Rat)	10 ppm (35 mg/m^3) PEL	OSHA MSDS	Not a carcinogen/May cause eye and skin irritation. May be harmful if swallowed and may cause respiratory tract irritation.	Chemical intermediate, solvent	F-120
Butyric Acid (CAS 107-92-6)	Not Applicable	2000	Skin (Rabbit)	Not Found	OSHA MSDS	Not a carcinogen/Causes eye, skin, digestive, and respiratory burns and irritation		F-122
Calcium Oxide (CAS 1305-78-8) (500 lbs)	Not Applicable	Not Found	Not Found	5 mg/m^3 TWA	OSHA MSDS	Not a carcinogen/Causes severe irritation and burns to every area of contact. Harmful if swallowed or inhaled.		F-123
Carbon fibers and nanotubes, various sizes	Not Applicable	>5000	Oral (Rat)	15 mg/m^3 TWA	OSHA MSDS	Possible carcinogen/Irritating to eyes, respiratory system and skin.		F-123

Test Material EIS Entry	Agent Simulated	[1,2]Lethal Dose (LD_{50})/Lethal mg/kg	Route	[1,2]Occupational Exposure Level Value	Reference	[1,2]Carcinogenicity/Human Toxicity	Additional comments	Discussion of Material
Cetyltrimethyl ammonium bromide (CAS 57-09-0)	Not Applicable	410	Oral (Rat)	5 ppm (33 mg/m^3) PEL	NIOSH	Not a carcinogen/Causes severe irritation and harmful if swallowed or inhaled.		F-124
Cetyltrimethylammonium chloride (CAS 112-02-7)	Not Applicable	Not Found	Not Found	Not Found	Not Found	Not a carcingen/Irritating to skin.respiratory, and mucous membranes.		F-125
Chlorine (7782-50-5)	Not Applicable	LC 293 ppm/1 hour	Inhalation (Rat)	1 ppm (3mg/m3) ceiling/0.5 (1.5 mg/m^3) TWA	OSHA MSDS	Not a carcinogen/Harmful if inhaled, respiratory tract burns, eyes burn, and skin burns.		F-126
Chlorine Pentafluoride (ClF_5) (CAS 13637-63-3)	Not Applicable	LC50 122 mg/L 1 hour	Inhalation (Rat)	Not Found	MSDS	Possible carcinogen/Causes severe burns to eyes, skin, respiratory and digestive system.		F-126
Chlorine Trifluoride (ClF_3) (CAS 7790-91-2)	Not Applicable	299 mg/L	Inhalation (Rat)	0.1 ppm PEL	OSHA MSDS	Not a carcinogen/Severe eye, skin, respiratory and digestive burning and irritation		F-127
Cyclohexyl mercaptan (CAS 1569-69-3)	Not Applicable	2 mg/24H	Draize Test, (Rabbit) skin	2.4 mg/m^3 PEL	NIOSH MSDS	Possilbe carcinogen/Eye, skin, respiratory and digestive irritant. Possibly causes cardiac abnormalities and metabolic acidosis.		F-128
Ethyl 2-cyanoacrylate (CAS 7085-85-0)	Not Applicable	>5000	Oral UK	0.2 ppm TLV	MSDS ACGIH	Not a carcinogen/Eye, skin irritation. Can result in dermatitis		F-128
Ethyl mercaptan (CAS 75-08-1)	Not Applicable	682	Oral (Rat)	1.3 mg/m^3 TWA	MSDS ACGIH	Not a carcinogen/Eye, skin irritation. Acute problems occur if inhaled or ingested.	Odorant for natural gas; maufactured in pesticides and plastics.	F-129
Fog Oil (Naphthenic Oil) (CAS 64742-52-5)	Not Applicable	LD >5000	Oral (Rat)	5 mg/m^3 (as oil mist) PEL	MSDS ACGIH 8hrs	Not a carcinogen/Eye, skin, irritation.Heated oil will cause irritation to respiratory system.		F-130
Glycerol (CAS 56-81-5)	Not Applicable	12600	Oral (Rat)	15 mg/m^3 Total Dust TLV	MSDS OSHA/ACGIH	Not a carcinogen/ Eye, skin, respiratory and digestive irritant.		F-131
Hexachlorobenzene (CAS 118-74-1)	Not Applicable	2600	Oral (Rabbit)	0.002 mg/m^3 TLV	ACGIH MSDS	Possible carcinogen/Eye, skin, respiratory irritant		F-132
Isopropyl mercaptan (CAS 75-33-2)	Not Applicable	130000mg/m^3/1H (LC50)	Inhalation (Mouse)	Not Found	OSHA MSDS	Not a carcinogen/Irritating to eyes, respiratory system and skin.		F-134
Magnesium Oxide, MgO (CAS 1309-48-4)/(2.20 lbs per test)	taggant/tracer	810	Muscle (Unknown)	10 mg/m^3 TLV, 15 mg/m^3	ACGIH, OSHA MSDS	Not a carcinogen/Eye, skin, respiratory , and digestive irritant		F-135
Mercaptoacetic acid (CAS 68-11-1)	Not Applicable	114	Oral (Rat)	4 mg/m^3 TWA	NIOSH MSDS	Not a carcinogen/Causes severe burns to eyes,skin, respiratory system. Toxic by ingestion.		F-136
2-Mercaptoethanol (CAS 60-24-2)	Not Applicable	244	Oral (Rat)	0.2 ppm 8 hour TWA	AIHA MSDS	Carcinogenic/May cause severe eye, skin, respiratory, and digestive irritation.		F-137
3-Mercaptopropionic acid (CAS 107-96-0)	Not Applicable	96	Oral (Rat)	NE	MSDS	Not a carcinogen/ Causes eye, skin, digestive, and respiratory burns.		F-138

Test Material		[1,2]Lethal Dose (LD_{50})/Lethal		[1,2]Occupational Exposure Level		[1,2]Carcinogenicity/Human		Discussion of
EIS Entry	Agent Simulated	mg/kg	Route	Value	Reference	Toxicity	Additional comments	Material
3-Methyl indole (CAS 83-34-1)	Not Applicable	3450	Oral (Rat)	NL	OSHA MSDS	Not a carcinogen/Irritating to eyes, respiratory system and skin.		F-139
Methyl mercaptan (CAS 74-93-1)	Not Applicable	LC 675 ppm	Inhalation (Rat)	20 mg/m^3 PEL	OSHA MSDS	Possible carcinogen/Very toxic by inhalation. Irritating to eyes, respiratory system and skin.	Intermediate in the manufacture of pesticides, fungicides, jet fuels, and added to natural gas to give odor	F-140
1-Methyl-1-propanethiol (CAS 513-53-1)	Not Applicable	NL	NL	NE	OSHA MSDS	Not a carcinogen/Eye, respiratory, skin irritant. Lung-aspiration hazard.		F-141
2-Methyl-2-propanethiol (CAS 75-66-1)	Not Applicable	4729	Oral (Rat)	NL	OSHA MSDS	Possible carcinogen/Skin, eye, respiratory and digestive tract irritant. Can produce unconsciousness with cyanosis.		F-142
Methyltrioctadecylammonium bromide (CAS 18262-86-7)	Not Applicable	NL	NL	NL	NL	Not a carcinogen/Eye, skin, respiratory and digestive irritant.		F-143
Methltrioctylammonium bromide (CAS 35675-80-0)	Not Applicable	NL	NL	NL	NL	Not a carcinogen/Eye, skin, respiratory and digestive irritant.		F-143
Methyltrioctylammonium chloride (CAS 63393-96-4)	Not Applicable	NL	NL	NL	NL	Not a carcinogen/Eye, skin, respiratory and digestive irritant.		F-144
1-Octanethiol (CAS 111-88-6)	Not Applicable	2000	Oral (Rat)	3.0 mg/m^3 (15-min) PEL	NIOSH	Not a carcinogen/Eye, skin, repsiratory irritation		F-144
2,2'-Oxydiethanethiol (2-mercaptoethyl ether) (CAS 2150-02-9)	Not Applicable	Not Found	Not Found	Not Found	Not Found	Not a carcinogen/Irritating to eyes, respiratory system and skin.		F-145
Polyethylene glycol (CAS 25322-68-3)	Not Applicable	>15000	Oral (Rat)	10 mg/m^3 as an aerosol TWA	MSDS ACGIH	Not a carcinogen/respiratory and digestive irritant.		F-145
Terephthalic Acid (CAS 100-21-0)	Not Applicable	>6400	Oral (Rat)	10 mg/m^3, 15 mg/m^3 TLV	ACGIH MSDS	Not a carcinogen/Eye, skin, respiratory and digestive irritant.		F-146
Tetraoctylammonium bromide (CAS 14866-33-2)	Not Applicable	NL	NL	NL	NL	Not a carcinogen/Eye, skin, respiratory and digestive irritant.		F-147
Tetraoctylammonium chloride (CAS 3125-07-3)	Not Applicable	NL	NL	NL	NL	Not a carcinogen/Eye, skin, respiratory and digestive irritant.		F-148
Thiophenol (CAS 108-98-5)	Not Applicable	46.2	Oral (Rat)	0.5 mg/m^3 15 min PEL	NIOSH MSDS	Not a carcinogen/May cause severe eye, skin, respiratory, and digestive irritation burns.		F-148
Trimethylamine (TMA) (CAS 75-50-3)	Not Applicable	500	Oral (Rat)	100 mg/m^3 PEL	OSHA MSDS	Not a carcinogen/May cause severe eye, skin, respiratory, and digestive irritation burns.		F-149
Tungsten (VI) Fluoride (WF_6) (CAS 7783-82-6)	Not Applicable	LC50 1430 mg/m3	Inhalation (Rat)	2.5 mg/m^3 TWA	OSHA MSDS	Not a carcinogen/Toxic by inhalation, in contact with skin and when swallowed. It will causes burns on the eyes.		F-151

Alternative Two

Chemical Simulants

Test Material		[1,2]Lethal Dose (LD_{50})/Lethal		[1,2]Occupational Exposure Level		[1,2]Carcinogenicity/Human Toxicity	Additional comments	Discussion of Material
EIS Entry	Agent Simulated	mg/kg	Route	Value	Reference			
Bis(2-ethylhexyl) phosphate (DEPHA) (CAS 298-07-7)(4000 gal)	nerve agent simulant; detector testing; decontamination testing	4800	Oral (Rat)	Not Found	MSDS	Not a carcinogen/ Found to be corrisive to eye, skin, respiratory system, ingestion system.		F-152
2-Chloroethyl ethyl sulfide (CEES) (CAS 693-07-2)(4000 gal)	mustard simulant; detector testing	252	Oral (Rat)	Not Found	OSHA MSDS	Not a carcinogen/Severe eye,skin, respiratory irritatant		F-153
Diethyl methyl phosphonate (DEMP) (CAS 683-08-9)(4000 gal)	nerve agent simulant; detector testing; decontamination testing	2240	Oral (Rat)	Not Found	MSDS	Not a carcinogen/Eye, skin, respiratory, digestive irritatant		F-154
Diisopropyl fluoro phosphate (DFP) (CAS 55-91-4)(4000 gal)	thickened agent simulant	5	Oral (Rat)	Not Found	OSHA MSDS	Not a carcinogen/Very toxic by inhalation, in contact with skin and if swallowed		F-154
Diisopropyl methyl phosphonate (DIMP) (CAS 1445-75-6) (4000 gal)	nerve agent simulant	826	Oral (Rat)	0.85 mg/m^3 PEL	Sanata Clara HBEL	Not a carcinogen/Eye, respiratory irritatant	Detector testing	F-155

Teracer and Taggants

Lead (II) Selenide, powder (CAS 12069-00-0)	taggant	50-600 (as Pb), LC50 4400 ppb (as Se)	oral (calves) (as Pb), NK (pinfish, *Lagodon rhomboides*)	0.05 mg/m^3 (as Pb), 0.2 (as Se) TLV	ACGIH MSDS	Possible carcinogen/ Harmful if ingested or inhalaed. Skin and eye irritant.	LD_{50} and OEL based on individual compounds from MSDS and US National Library of Medicine-Specialized Information Services (USNLM-SIS)	F-156
Lead (II) Telluride (CAS 1314-91-6)	taggant	50-600 (as Pb)/NL	oral (calves) (as Pb),/NL	0.05 mg/m^3 TWA (as Pb), 0.1 (as Te) TLV	ACGIH MSDS	Possible carcinogen/Eye, skin, digestive, and respiratory irritant	PEL based on individual compounds from MSDS	F-157
Mercuric Sulfide Red (CAS 1344-48-5)	taggant	8	Intraperitoneal (Mouse)	0.01 mg/m^3 PEL	OSHA	Not a carcinogn/Very toxic by inhalation, in contact with skin and if swallowed	Lethal dose and PEL based on mercury compounds	F-158
Mercury (II) Selenide (CAS 20601-83-6)	taggant	8	Intraperitoneal (Mouse)	0.01 mg/m^3 PEL	OSHA	Not a carcinogen/Material is irritating to mucous membranes and upper respiratory tract, eyes, and skin.	Lethal dose and PEL based on mercury compounds	F-159
Mercury (II) Telluride (CAS 12068-90-5)	taggant	8	Intraperitoneal (Mouse)	0.1 mg/m^3 PEL	OSHA MSDS	Not a carcinogen/Toxic if inhalaed or ingested but irritanting to eye and skin.	Lethal dose based on mercury compounds	F-160

LC = Lethal Concentration

Footnotes: [1] See references in Volumne II Sheets

Concentration equalvalents: 1 ppm = 1 mg/m^3

OEL: Occupational Exposure Level
PEL: Permissible Exposure Level

TWA: Time Weighted Average
TLV: Threshold Limit Value

NIOSH: National Institute for Occupational Safety and Health
OSHA: Occupational Safety and Health Administration

Test Material		[1,2]Lethal Dose (LD_{50})/Lethal		[1,2]Occupational Exposure Level		[1,2]Carcinogenicity/Human		Discussion of
EIS Entry	Agent Simulated	mg/kg	Route	Value	Reference	Toxicity	Additional comments	Material

STEL: Short Term Exposure Limit   TDLo: Lowest published toxic dose   ACGIH: American Conference of Industrial Hygienists

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APPENDIX H

ENVIRONMENTAL FATE DATA FOR DTRA TEST MATERIALS

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Test Material	Test Use	Vapor Presure/Solubility in Water	Soil Adsorption Tendency	Expected tendency for leaching	Degradation Rates	Hazardous Decomposition Products and By-Products	Discussion of Material
Biological Simulants (Amount per test)							
Bacillus subtilis var. niger (formerly *Bacillus globigii*) (BG) (200 lbs)	anthrax simulant	Not Applicable/[1]Insoluble	Not Applicable	Not Applicable	[1]Soil: slow	[2]Not Applicable	F-5
Bacillus thuringiensis bacteriophage (5 lbs/test)	taggant	Not Found/Insoluble	Not Applicable	Not Applicable	Not Applicable	Not Applicable	F-8
Bacillus thuringiensis (BT) (200 lbs) (CAS 68038-71-7)	anthrax simulant	Not Applicable/[1]Insoluble	[1]Low	[1]Not Applicable	[1]Not Applicable	[2]Not Applicable	F-8
Clostridium sporogenes (150 lbs)	*Clostridium botulinum* simulant	Not Applicable/ Not Applicable	Not Applicable	Not Applicable	Not Applicable	[2]Not Applicable	F-10
Erwinia herbicola (Ec) (200 lbs/test)	Plague simulant to spt PAD testing	Not Applicable/Not Applicable	Not Applicable	Not Applicable	[1]Not Applicable	[2]Carbon dioxide, carbon monoxide	F-11
Lactic Dehydrogenase (LDH) (200 lbs)	botulinum toxin simulant	Not Applicable/Not Applicable	Not Applicable	Not Applicable	[1]Not Applicable	[2]Not Applicable	F-12
MS2 Bacteriophage (150 lbs)	non-eveloped virus simulant	Not Applicable/Not Applicable	Not Applicable	Not Applicable	[1]Not Applicable	[2]Not Applicable	F-12
Noninfectious (killed) Influenza A Virus (150 lbs)	enveloped virus simulant	Not Applicable/ Not Applicable	Not Applicable	Not Applicable	[1]Not Applicable	[2]Carbon dioxide, carbon monoxide	F-13
Ovalbumin (200 lbs) (CAS 9006-59-1)	ricin toxin simulant	Not Applicable/[2]Appeciable (>10%) soluble	Not Applicable	Not Applicable	[1]Not Applicable	[2]Carbon dioxide, carbon monoxide	F-14
Chemical Simulants (Amount per test)							
1, 3, 5 Trimethylbenzene (mesitylene) (CAS 108-67-8) (4000 gal)	evaporation studies; decontamination testing	[2]1.86 mmHg @ 20C/ [3]Solubility: 48.2 mg/L	Not Found	Not Found	[4]Soil: 2-8 days [4]Atmosphere: 0.24-2.4 hours [4]Aquatic: Surface Water: 2-8 days/Ground Water: 4-16 days	[2]Carbon dioxide and carbon monoxide may form when heated to decomposition.	F-15
Bis (2-ethylhexyl) hydrogen phosphite (Bis) (CAS 3658-48-8)(4000 gal)	nerve agent simulant; detector testing; decontamination testing	Not Found/Not Found	[4]Moderate	[4]Low	[4]Soil:hydrolysis half-life in the order of weeks is estimated [4]Atmosphere: 23 hours [4]Water: 19 and 87 days (Hydrolysis-comparison to CAS 868-85-9 and 762-04-9 used)	[2]Carbon dioxide ,carbon monoxide, phoshorus acid or its salts and the alcohol.Thermal decomposition may produce toxic fumes of phosphorus oxidesand/or phoshine.	F-16
Diethyl malonate (CAS 105-53-3)(4000 gal)	nerve agent simulant	[2]1 mmHg @ 40 C/[4]Solubility: $2.32x10^4$ mg/L	Not Found	Not Found	[1]Soil: 2 h for the fast component and 5 to 16 h for the residual material.	[2]Carbon monoxide irriating and toxic fumes and gases, carbon dioxide.	F-18
Diethyl phthalate (CAS 84-66-2)(4000 gal)	nerve agent simulant; detector testing; decontamination testing	[4]$2.5x10^{-3}$ mmHg @25 C/ [3]Solubility:1080 mg/L	[4]High	Not Found	[4]Soil: 3-56 days [4]Atmosphere: 8.8 days [4]Aquatic: Surface Water: 3-56 days/Ground Water: 6-112 days	[2]Carbon monoxide and carbon dioxide may form when heated to decomposition.	F-18
Dimethyl Methylphosphonate (DMMP) (CAS 756-79-6) (4000 gal)	nerve agent simulant	[1]0.87 mmHg/ [3]Solubility: $1x10^6$ mg/L	[4]Low	[4]High	[4]Soil: 0.2-60 days [4]Aquatic: 7-210 days [4]Atmosphere: 1.6 months	[2]Toxic fumes of carbon monoxide, carbon dioxide, phosphorus oxides and/or phosphine	F-20

Test Material	Test Use	Vapor Presure/Solubility in Water	Soil Adsorption Tendency	Expected tendency for leaching	Degradation Rates	Hazardous Decomposition Products and By-Products	Discussion of Material
Dipropylene glycol monomethyl ether (DPM; DPGME) (CAS 34590-94-8) (4000 gal)	nerve agent simulant	[2]0.5 mmHg/[3]Solubility: 1x10^6 mg/L	[4]Low	[4]High	[1]Soil: moderate [4]Atmosphere: 3.4 hours [4]Aquatic: 100% degradation [1]Biogradadation: moderate [1]Photodegradation: fast	[2]Carbon dioxide, carbon monoxide	F-22
Glyceryl tributyrate (CAS 60-01-5)(4000 gal)	nerve agent simulant; detector testing; decontamination testing	[2]0.0013 mmHg (est)/ [3]Solubility: 133 mg/L	[4]High	[4]Low	[1]Soil: Low [4]Atmosphere: 1.2 days [4]Hydrolsis: 25 and 250 days	[2]Carbon monoxide , carbon dioxide, toxic fumes and gases,	F-23
Methyl salicylate (MeS) (CAS 119-36-8) (4000 gal)	mustard simulant	[2]0.1 mmHg @ 20 C/[3]Solubility:700 mg/L	[1]Low	[1]Moderate	[1]Soil: biodegrad.-Moderate - fast [4]Atmosphere: 1-10 days [4]Aquatic: 22 days [1]Hydrolsis: 22 days (in soil)	[2]Toxic fumes under fire conditions: carbon monoxide, carbon dioxide[2]	F-24
Propionic acid (CAS 79-09-4)(4000 gal)	nerve agent simulant; detector testing; decontamination testing	[4]3.53 mmHg @ 20C/ [4]Solubility: 1.0x10^6 mg/L	[4]Low	[4]High	[4]Atmosphere: 11-14 days Photodegrad. [4]Aquatic: Volatilization not expected	[2]Carbon dioxide and carbon monoxide may form when heated to decomposition.	F-26
Thiodiglycol (TDG) (CAS 111-48-8) (4000 gal)	mustard simulant	[1]0.00002 mmHg/[3]Solubility: 1x10^6 mg/L	[1]Low	[1]High	[4]Soil (Experimental value): 5 days [4]Aquatic: 42 days [1]Biodegrad: none to moderate, soil dependent [1]Hydroylsis: very slow	[2]Toxic fumes of carbon monoxide, carbon dioxide, sulfur oxides, and hydrogen sulfide gas.	F-27
Tributyl phosphate (CAS 126-73 8) (4000 gal)	nerve agent simulant; detector testing; decontamination testing	[2]0.004 mmHg /[3]Solubility: 280 mg/L	[4]High	[1]None - Low	[1]Soil: biodegrades [4]Atmosphere: 4.9 Hrs photochemically [1]Aquatic: 4-7 days (est. from study) and hydrolyzes very slowly; biodegrades	[2]Toxic fumes carbon monoxide, carbon dioxide, thermal decomposition may produce phosporus oxides, and/or phoshine.	F-28
Triethyl Phosphate (TEP; TEPO) (CAS 78-40-0) (4000 gal)	nerve agent simulant; detector testing; decontamination testing	[2]1 mmHg @20C/[3]Solubility:5x10^5 mg/L	[4]Low	[4]High	[1]Soil: Slow [4]Atmosphere: 7 hours photochemically [4]Aquatic: 114 years	[2]Toxic fumes of carbon dioxide, carbon monoxide, phosphorus oxides when burned.	F-29
Triethyl Phosphite (TEPI) (CAS 122-52-1) (4000 gal)	nerve agent simulant; detector testing; decontamination testing	Not Available/ [1]Solubility: Insoluble	Not Found	[1]Low	Not Found	[2]Toxic fumes of carbon monoxide, carbon dioxide, phosphorus oxides.	F-31
Triisopropyl phosphate (CAS 513-02-0)(4000 gal)	nerve agent simulant	Not Available/Not Available	Not Found	Not Found	Not Found	[2]Carbon monoxide, carbon dioxide, phosphorus oxides.	F-31
Trimethyl phosphite (CAS 121-45-9)(4000 gal)	nerve agent simulant; detector testing; decontamination testing	[2]24 mmHg@ 77F/ [3]Solubility: 7200 mg/L	Not Found	Not Found	Not Found	[2]Carbon monoxide, oxides of phosporus, carbon dioxide.	F-32
Tripropyl phosphate (CAS 513-08-6)(4000 gal)	nerve agent simulant; detector testing; decontamination testing	[1]0.043 mmHg @20C/Solubility: 6450 mg/L	Not Found	Not Found	[1]Soil: biodegrades slow (est). [1]Atmosphere: 5 to 7 hours [1]Aquatic: hydrolyzes and biodergrades	[2]Carbon monoxide, carbon dioxide,thermal decomposition may produce toxic fumes of phosphorus oxides and/or phosphine.	F-33

Radiological Simulants

Test Material	Test Use	Vapor Presure/Solubility in Water	Soil Adsorption Tendency	Expected tendency for leaching	Degradation Rates	Hazardous Decomposition Products and By-Products	Discussion of Material
Cerium dioxide (CeO2) (CAS 1306-38-3)(5 kg/test)	radiological dispersal device simulant	Not Available/ [2]Insoluble in water	Not Found	Not Found	Not Found	[2]Carbon monoxide, irriatating and toxic fumes and gases, and carbon dioxide	F-35
Cesium chloride (CsCl) (CAS 7647-17-8)(5 kg/test)	radiological dispersal device simulant	Not Available/ [2]Insoluble in water	Not Found	Not Found	Not Found	[2]Toxic fumes may form when heated to decomposition	F-35
Manganese dioxide (MnO2) (CAS 1313-13-9)(5 kg/test)	radiological dispersal device simulant	[2]Negligible/[4]1.886 kg/L	Not Found	Not Found	Not Found	[2]Oxides of the contained metal and halogen, possibly also free,or ionic halogen	F-36
Strontium titanate (SrTiO3) (CAS 12060-59-2)(5 kg/test)	radiological dispersal device simulant	Not Available/ [2]Insoluble in water	Not Found	Not Found	Not Found	[2]May emit toxic fumes when heated to decomposition (strontium oxide, titanium oxide)	F-37
Tracers and Taggants (Amount per test)							
BAS-Oil Red Dye (20 gal)	Dye, plume taggant	[2]Slower then ether/[2]Not soluble	Not Found	Not Found	Not Found	[2]Fumes, smoke, carbon monoxide, sulfur oxides, aldehydes, other oxides	F-39
Carbon Tetrafluoride (CF4) (CAS 75-73-0) (150 lbs)	Plume tracer	[2]799 mmHg (@ -127°C) /[3]Solubility: 18.8 mg/L	Low	[1]Low	[4]Soil: High mobility [4]Atmosphere: > 110 years [4]Aquatic (lake model): 3.7 days/(river model) 2.7 hours	[2]Carbon monoxide, carbon dioxide, hydrogen fluoride, thionyl fluorides	F-39
2-Diethylamino ethanethiol (CAS 1942-52-5) (400 gal/test)	tracer	Not Available/ [2]Soluble in water	Not Found	Not Found	Not Found	[2]Hydrogen chloride, nitrogen oxides, carbon monoxide, irritating and toxic fumes and gases, carbon dioxde, nitrogen	F-40
2-Diisopropylamino ethanethiol (CAS 41480-75-5) (400 gal/test)	tracer	Not Available/Not Available	Not Found	Not Found	Not Found	[2]Nitrogen oxide, carbon monoxide, carbon dioxide, nitrogen, sulfur oxides (Sox), including sulfur dioxide and sulfur monoxide.	F-41
Dysprosium Oxide (CAS 1308-87-8) (100 lbs)	Plume tracer	Not Available/[4] Insoluble	Not Found	Not Found	Not Found	[2]Carbon dioxide, carbon monoxide	F-42
Fluorescein (CAS 2321-07-5) (1	taggant	Not Available/ [4]Insoluble in water	Not Found	Not Found	Not Found	[2]Carbon monoxide and carbon dioxide may form when heated to decomposition	F-43
Forane 134A (1,1,1,2-tetrafluoroethane) (CAS 811-97-2) (100 lbs)	Plume tracer	[4]4730 mm Hg @ 25 C (est) /[3]Solubility: 2040 mg/L	Moderate - High	Low	[4]Soil: Not Available [4]Atmosphere: 1878 days Photochemically [4]Aquatic: 3.0 hours model river Volatilization	[2]Carbon dioxide, carbon monoxide, hydrogen fluoride, hydrogen chloride, chlorine	F-43
Indium Oxide (CAS 1312-43-2) (100 lbs)	Plume tracer	[2]< 0.01 mm Hg @25 C/ [2]Not soluble	[1]Moderate - High moblity	[1]Low	[4]Based on Indium compounds Soil: $4.4X10^{+14}$ years [4]Atmosphere: Not Available [4]Aquatic: Not expected to undergo hydrolysis	[2]Toxic fumes	F-44
Locate Blue Liquid Dye (40 gal) 9 Used Trypan blue(TB), CI Direct Blue 15(BL15))	Dye, plume taggant	Not Found/[4]Soluble	[4]Low (TP/BL15)	[4]Moderate (TP/BL15)	[4]Atmosphere: exist in particulte phase (BL15/TB) [4]Aerobic biodegradation: 7 days	[2]Carbon monoxide, nitrous oxides, acetic acid	F-46

Test Material	Test Use	Vapor Presure/Solubility in Water	Soil Adsorption Tendency	Expected tendency for leaching	Degradation Rates	Hazardous Decomposition Products and By-Products	Discussion of Material
Malachite green (CAS 633-03-4) (110 lbs/test)	taggant	Not Found/ [3]Solubility: 4.0x10^4 mg/L	[4]May adsorb to clay sediments and particulate matter in the water due to ion-exchange processes.	[4] Its ionic nature may result in ion-exchange processes with clay that would retard leaching.	[4]Biodegradation - slow for soil, water	[2]May form carbon oxides, nitrogen oxides, and sulfur oxides when heated to decomposition	F-48
Pentafluoroethane (PFE; Halocarbon 125; Zyron 125) (CAS 354-33-6) (250 lbs/test)	tracer to spt PAD testing	[4]1.05X10^{+4} mm Hg @ 25 C/ [3]Solubility: 923 mg/L	Not Found	[4]Moderate	[4]Biodegrade-slow [4]Atmoshere: 18 years [4]Aquatic river model 3.2 hours/ lake model 4.3 days	[2]Halogens,halogens acids and and carbonyl halides	F-49
Scandium Oxide (CAS 12060-08-1) (100 lbs)	tracer to spt PAD testing	[2]0 mmHg/[2]Insoluble in water	Not Found	Not Found	Not Found	[2]Irritating and toxic fumes and gases.	F-50
Sulfur Hexafluoride (SF_6) (CAS 2551-62-4) (250 lbs)	Plume tracer	[2]16340 mmHg/ [3]Solubility: 31 mg/L	[4]Low	[4]High	[4]Atmosphere:~600 years by photolysis [4]Aquatic:model river 3.5 hours/lake model 4.8 days by volatilization	[2]Sulfur oxides, hydrogen fluorides	F-51

Interferents
(Amount per test)

Bleach (Sodium Hypochlorite) (55 Gal) (CAS 7681-52-9)	Decontaminant interferent	[2]17.5 mmHg @ 20°C/ [4]Solubility: 29.3 g/100 g	Not Found	Not Found	Not Found	[2]Carbon dioxide, carbon monoxide, chlorine gas, chlorine oxides.	F-55
Burning butyl rubber (burning organics) (increase from 4 to 12 large tires)	Interferent	Not Found/[2]Soluble in organic solvents.	Not Found	Not Found	Not Found	[2]Oxides of carbon and nitrogen; trace amount of cyanides under burning conditions.	F-56
Burning Kerosene or diesel fuel (combustion products) (100 gal) (Based on Kerosene)	Interferent	[2]1 mmHg@ 20C/ [2]Insoluble in water	[1]Low	[1]Moderate	[1]Soil: Low mobility [1]Atmosphere: 2-3 days [1]Aquatic models: 3.6 Hrs river/>130 days lake	[2]Carbon dioxide and carbon monoxide may form when heated to decomposition.	F-57
Burning Plastic (burning organics) (15 lbs) (Values based on Methyl Methacrylate CAS 80-62-6)	Interferent	[4]38.5 mm Hg @ 25 C /[4]Solubility: 2700mg/L	[4]Low	[4]Leach into groundwater where its fate is unknown.	[4]Atmosphere: 7.4 hours photochemically [4]Aquatic models: 6 hours river/5 days lake model volatilization	[2]Carbon dioxide, carbon monoxide, sulfur oxides, nitrogen oxides, unknown organic compounds dioxide, Methyl methacrylate, butyl acrylate.	F-56
Burning Wood (burning organics) (100 lbs) (Valued on Creosote, Wood CAS 8021-39-4)	Interferent	[2]Not Applicable/[3]150-200 mg/L	Not Applicable	Not Applicable	[4]Atmosphere:Not Available [4]Aquatic Study:< 1 wk to degrade in seawater.	[2]Carbon dioxide, carbon monoxide, aldelhydes, amines, ammonia, hydrogen chloride, oxides of carbon and nitrogen	F-56

Other Test Material
(Amount per test)

Bentonite Clay (CAS 1302-78-9) (100 lbs/test)	Inert filter/dust	Not Applicable/[4]Insoluble	Not Applicable	Not Applicable	[1]Does not degrade	[2]Irritating and toxic fumes and gases.	F-59
Kaolin (600 lbs) (CAS 1332-58-7)	Thickener	[2]0 mmHg (approx)/ [1]Insoluble in water	Not Found	Not Found	Not Applicable	[2]Carbon dioxide, carbon monoxide	F-60
Luria Broth (LB) (55 lbs/test)	Additive	Not Found/[2]Solublity: 35.7g/100g at 0^{o}C	Not Found	Not Found	Not Found	[2]Carbon dioxide, carbon monoxide	F-61
Magnesium chloride (250,000 lbs) (CAS 7786-30-3)	NA	Not Found/[4]54.1 m/100g	Not Found	Not Found	Not Available	[2]Magnesium oxychloride, hydrochloric acid vapor, chlorine gas	F-61
Oleoresin capsicum (10 lbs) (CAS 404-86-4)	NA	[2]< 10 mmHg/[2]Fully dispersible	Low (est)	Low	Natural occuring material.	[2]Pungent fumes may be emitted when heat above 170 F	F-62

Test Material	Test Use	Vapor Presure/Solubility in Water	Soil Adsorption Tendency	Expected tendency for leaching	Degradation Rates	Hazardous Decomposition Products and By-Products	Discussion of Material
Phenol (22 lbs) (CAS 108-95-2)	Preservative	[2]0.4 mmHg @ 20C/ [3]Solublity: $8.28x10^4$ mg/L	[4]Low	High	[4]Soil: 1-10 days [4]Atmosphere:2.28-22.8 Hrs [4]Aquatic: Surface Water: 0.22 -2.4 days/Ground water: 0.5-7 days	[2]Carbon monoxide, carbon dioxide may form when heated to decomposition. Toxic gases and vapors may be releasedif involved with fire.	F-63
Polymethyl Methacrylate (PMMA) (2300 lbs) (CAS 9011-14-7)	Thickener	[2]29.3 mm Hg @ 20 C/ [2]Solublity is < 0.1 % in water	Not Found	Not Found	Not Found	[2]Carbon dioxide, carbon monoxide, monomeric methylmethacrylate	F-65
Polystyrene (CAS 9003-53-6) (25 lbs/test)	Plastic bottles	[2]6.40 mm Hg @ 25 C /[4]310 mg/L	[4]High	[4]Low	[4]Soil: 31 days (Experimental value) Volatilized [4]Atmosphere: >6 Hrs/Vapor-phase 7Hrs [4]Aquatic :Experimental 50% of 2 to 10 mg styrene per liter (depth not specified) was lost by volatilization in 1 to 3 hrs in lake water samples and in 6 to 7 hrs in distilled water.	[2]Carbon dioxide, carbon monoxide	F-67
Polystyrene-Butylmethacrylate (PSBA) (2300 lbs)	Thickener	[2]6.40 mm Hg @ 25 C(PS)/(PS)-Insoluble in water [2]40 mm Hg @ 25.5 C(BA)/Solubility: 800mg/L (BA)	PS Low/BA Not Available	PS Low/BA High	Biodegrade 28 days (BA) Soil: PS Not biodegradable [4]Atmosphere: PS NK/2.7 hours (photo.) [4]Aquatic: PS Not Biodegradable/6.3	[2]Carbon dioxide, carbon monoxide	F-67
Sand (silica) (CAS 14808-60-7) (25 lbs/test)	Inert filter/dust	Not Available/[2]Insoluble in water	Not Applicable	Not Applicable	Not Applicable	[2]At higher tempertuatures, can change crystal structures to form tridymite or cristobalite, which have greater health hazards.	F-68
Silicon (CAS 7440-21-3) (5 lbs/test)	Inert filter/dust	[2]0 mmHg (approx)/[2]Insoluble	High	Low	Not Applicable	[2]Irriatating and toxic fumes and gases, oxides of silicon	F-69
Smokecloak FL 600 Fluid (3 gal)	Test weapon additive	2.4 kPa/Completely miscible	Low (est)	Moderate to High (est)	Not Found	Oxides of carbon and including aldehydes	F-70
Sticky Foam (1200 lbs)	Test weapon additive	[2]Not Applicable/[2]Insoluble	Moderate to High	Low	Not Found	Thermal decomposition products as oxides of oxide. If the product is heated to temperatures sufficient to produce smoke or fumes the TLV-TWA for rosin pyrolysis products should be observed.'	F-71
Tergitol 15-S-9 Nonionic (20 lbs) (CAS 68131-40-8)	Anticonglomerate	[2]<1 mmHg/Solubility in water miscible	Not Found	Not Found	[1]Biodegrade- slow	[2]Carbon dioxide, carbon monoxide	F-73

High Explosives
(Amount per test)

AFX-757 (20,000 lbs)	Weapon warhead explosive (TB and Big BLU) (HELFIRE testing)	[5]1 mmHg @ 1284 C (Al)/[2]Insoluble in water -- (Al)	[5]High (Al)	[5]Low (Al)	Natural occuring material (Al)	[2]Toxic metal fumes may form when heated to decomposition (Al).	F-75
AFX-777 (2500 lbs)	Weapon warhead explosive	[5]1 mmHg @1284 C (Al)/ [2]Insoluble in water (Al)	[5]High (Al)	[5]Low (Al)	Natural occuring material (Al)	[2]Toxic metal fumes may form when heated to decomposition (Al).	F-75

Test Material	Test Use	Vapor Presure/Solubility in Water	Soil Adsorption Tendency	Expected tendency for leaching	Degradation Rates	Hazardous Decomposition Products and By-Products	Discussion of Material
Ammonium nitrate-fuel oil (ANFO) (500 Ton TNT equivalent)	Explosive mixture	[2]17.2 mm of Hg (@ 20°C) based on data for: water(AN)/[5]2.12-26.4 mmhG@21 C/[2]Solubility AN-192 g/100ml at 20^0C/FO-≈ 5 mg/L	[1]AN-Low/FO-High	[1]AN-High./FO-Low - moderate	[4]Soil: AN-Variable/FO-Low [4]Atmoshpere: AN-NK/FO-1 day or less Photochemically [4]Aquatic: AN-Fast/FO-4.4-4.8 hours (model river)	[2]Carbon dioxide, carbon monoxide, nitric oxide, ammonia, nitrogen dioxide, nitrous oxide, hydrogen cyanide, methane.	F-75
APHAS-4 (2500 lbs)	Weapon warhead explosive	Not Found	Not Found	Not Found	Not Found	Not Found	F-77
Composition 4 (C-4) (91% RDX; 9% plasticizer) (2 tons) (CAS 121-82-4)	Explosive mixture	[5]$1x10^{-9}$ mmHg @ 20 C(RDX)/[3]Solubility: 59.7 mg/L	[1]Low	[1]High	[4]Soil (RDX): 36 years/ Anaerobic soil cultures containing added potato starch, were able to completely degrade cyclonite within 24 days(9). Aerobic soil cultures, plus added potato starch, did not degrade cyclonite after 24 days of incubation(9). [4]Atmosphere: Not Available [4]Aquatic: hydrolyzed in sea Aquatic with 11.6% loss after 112 days.	[2]Carbon dioxide, carbon monoxide, ethane, methane, propane, methanol, hydrogen cyanide, ammonia, formaldehyde.	F-77
Cyclotetramethylenetetranitramine (HMX) (1 ton) (CAS 2691-41-0)	Explosive mixture	[5]$3.33x10^{-14}$ mmHg @ 25 C/[3]Solubility: 140 mg/L	[1]Moderate	[1]Moderate	[4]Soil: 39 Years [4]Atmosphere: 28.8 hours Aquatic: river (model) 37 hours/Pond (model) 17 days [1]Biogradation: Low [1]Photodegradation: Low	[2]Carbon dioxide, carbon monoxide, nitrogen oxides.	F-79
Cyclotrimethylenetrinitramine (RDX) (1 ton) (CAS 121-82-4)	Explosive mixture	[5]1x10-9 mmHg @ 20 C (RDX)/[3]Solubility: 59.7 mg/L	[1]Low	[1]High	[4]Soil: 36 years [1]Biogradation: Low [1]Photogradation: Moderate [4]Aquatic: photodegradation in the order of a few weeks	[2]Carbon dioxide, carbon monoxide, nitrogen oxides.	F-77
Emulsion Explosives Iregel-82, Iremite-62, QM-100, QM-100R (23 tons)	Explosive mixture	Not Found/[2]Insoluble	[1]Low	[4]Low	[4]Soil (RDX): 36 years/ Anaerobic soil cultures containing added potato starch, were able to completely degrade cyclonite within 24 days(9). Aerobic soil cultures, plus added potato starch, did not degrade cyclonite after 24 days of incubation [4]Atmosphere: NK [4]Aquatic: hydrolyzed in sea Aquatic with 11.6% loss after 112 days.	[2]Carbon dioxide, carbon monoxide, sodium carbonate, crystalline silica, acetylene, ethylene, methane, methanol, ammonia, formaldehyde.	F-80

Test Material	Test Use	Vapor Presure/Solubility in Water	Soil Adsorption Tendency	Expected tendency for leaching	Degradation Rates	Hazardous Decomposition Products and By-Products	Discussion of Material
GSI-0005 (2500 lbs)	Agent Defeat warhead fill (PAD program testing)	[2]kPa at 20°C: negligible (BA)/[2]1g/18ml in cold water (BA) [4]0.0285 torr @ 20 C/[2]Soluble in water (PA)	[4]pH dependent (BA)	Not Found	Not Found	[2]Loses chemically combined water upon heating forming, metabonic acid then pyroboric acid and boric anhydride at higher temperatures (BA). Oxides of phosphorus (PA).	F-81-82
GSI-0018 (2500 lbs)	Agent Defeat warhead fill (PAD program testing)	[2]kPa at 20°C: negligible (BA)/[2]1g/18ml in cold water (BA) [4]0.0285 torr @ 20 C/[2]Soluble in water (PA)	[4]pH dependent (BA)	Not Found	Not Found	[2]Loses chemically combined water upon heating forming, metabonic acid then pyroboric acid and boric anhydride at higher temperatures (BA). Oxides of phosphorus (PA).	F-81-82
HAS-4 (2500 lbs)	Weapon warhead explosive	[5]1 mmHg @ 1284 C(Al)/ [2]Insoluble in water (Al) [5]$3.33x10^{-14}$ mmHg @ 25 C/[3]140 mg/L (HMX).	[1]Moderate (HMX)	[1]Moderate (HMX)	[4]Soil: 39 Years (HMX) [4]Atmosphere: 28.8 hours [4]Aquatic: river (model) 37 hours/Pond (model) 17 days (HMX) [1]Biogradation: Low (HMX) [1]Photodegradation: Low (HMX)	[2]Toxic metal fumes may form when heated to decompition (Al) Oxides of nitrogen and carbon (HMX).	F-83
HAS-12 (2500 lbs)	Weapon warhead explosive	[5]1 mmHg @ 1284 C(Al)/ [2]Insoluble in water (Al) [5]$3.33x10^{-14}$ mmHg @ 25 C/[3]140 mg/L (HMX).	[1]Moderate (HMX)	[1]Moderate (HMX)	[4]Soil: 39 Years (HMX) [4]Atmosphere: 28.8 hours [4]Aquatic: river (model) 37 hours/Pond (model) 17 days (HMX) [1]Biogradation: Low (HMX) [1]Photodegradation: Low (HMX)	[2]Toxic metal fumes may form when heated to decompition (Al) Oxides of nitrogen and carbon (HMX).	F-84
MAC-112 (2500 lbs)	Weapon warhead explosive	Not Available	Not Found	Not Found	Not Found	Not Found	F-84
Nitromethane (NM) (20 tons) (CAS 75-52-5)	Explosive mixture	[2]27.8 mmHg @20C/[3]Solubility: $1.11x10^{5}$ mg/L	[1]Low	[1]Low	[1]Soil: fast [4]Atmosphere: Photolysis: 4-9 hours, Photochemically: 100 days [4]Aquatic: Volatilization in Pond(model): 28.7 hours/river (model): 13 days [1]Photodegradation: fast	[2]Carbon dioxide, carbon monoxide, nitrogen oxides.	F-82
PBXC-133 (2500 lbs)	Weapon warhead explosive	[5]$3.33x10^{-14}$ mmHg @ 25 C/[3]140 mg/L (HMX)	[1]Moderate (HMX)	[1]Moderate (HMX)	[4]Soil: 39 Years (HMX) [4]Atmosphere: 28.8 hours [4]Aquatic: river (model) 37 hours/Pond (model) 17 days (HMX) [1]Biogradation: Low (HMX) [1]Photodegradation: Low (HMX)	[2]Oxides of nitrogen and carbon (HMX).	F-85
PBXIH-135 (2500 lbs)	Weapon warhead explosive (TB and Big BLU) (HELFIRE testing)	[5]$3.33x10^{-14}$ mmHg @ 25 C(HMX)/[3]Solubility: 140 mg/L (HMX)	[1]Moderate (HMX)	[1]Moderate (HMX)	[4]Soil: 39 Years (HMX) [4]Atmosphere: 28.8 hours [4]Aquatic: river (model) 37 hours/Pond (model) 17 days (HMX) [1]Biogradation: Low (HMX) [1]Photodegradation: Low (HMX)	[2]Toxic oxides of nitrogen (RDX).	F-85

Test Material	Test Use	Vapor Presure/Solubility in Water	Soil Adsorption Tendency	Expected tendency for leaching	Degradation Rates	Hazardous Decomposition Products and By-Products	Discussion of Material
PBXIH-136 (2500 lbs)	Weapon warhead explosive	[5]$1x10^{-9}$ @ 20 C (RDX)/ [3]59.7 mg/L (RDX)	[1]Low (RDX)	[1]High (RDX)	[4]Soil: 36 years (RDX) [1]Biogradation: Low (RDX) [1]Photogradation: Moderate (RDX) [4]Aquatic: photodegradation in the order of a few weeks (RDX)	[2]Toxic oxides of nitrogen (RDX).	F-85
PBXN-103 (2500 lbs)	Weapon warhead explosive; enhanced 5000 class	[5]1.10^{-9} mmHg @ 20 C (RDX)/[3]59.7 mg/L (RDX)	[1]Low (RDX)	[1]High (RDX)	[4]Soil: 36 years (RDX) [1]Biogradation: Low (RDX) [1]Photogradation: Moderate (RDX) [4]Aquatic: photodegradation in the order of a few weeks (RDX)	[2]Toxic oxides of nitrogen (RDX).	F-85
PBXN-109 (2500 lbs) (Tritonal based)	Weapon warhead explosive (TB and Big BLU) (HELFIRE testing)	[4]$1.99x10^{-4}$ mmHg @ 20C (TNT)/[3]Solublilty 1.3x102 mg/L (TNT) [5]1 mmHg @ 1284 C (Al)/[2]Insoluble in water -- (Al)	[5]TNT- High	[5]TNT - Low	[4]Soil: 1 Year (TNT) [4]Aquatic: Volatilization river (model) 119 days (TNT) [1]Biodegrad: moderate (TNT) [1]Photodegrad: slow (in water) (TNT)	[2]Carbon dioxide, carbon monoxide, aluminum oxide, solid carbon, ethane, ammonia, hydrogen cyanide, propane, acetylene, methane, methanol, ethylene.	F-85
PBXN-111 (2500 lbs)	Weapon warhead explosive; enhanced 5000 class	[5]1.10^{-9} mmHg @ 20 C (RDX)/[3]59.7 mg/L (RDX)	[1]Low (RDX)	[1]High (RDX)	[4]Soil: 36 years (RDX) [1]Biogradation: Low (RDX) [1]Photogradation: Moderate (RDX) [4]Aquatic: photodegradation in the order of a few weeks (RDX)	[2]Toxic oxides of nitrogen (RDX).	F-85
PBXW-128 (2500 lbs)	Weapon warhead explosive	[5]$3.33x10^{-14}$ mmHg @ 25 C/[3]Solubility: 140 mg/L	[1]Moderate (HMX)	[1]Moderate (HMX)	[4]Soil: 39 Years (HMX) [4]Atmosphere: 28.8 hours [4]Aquatic: river (model) 37 hours/Pond (model) 17 days (HMX) [1]Biogradation: Low (HMX) [1]Photodegradation: Low (HMX)	[2]Oxides of nitrogen and carbon (HMX).	F-85
Pentaerythritol tetranitrate (PETN) (1000 lbs) (CAS 78-11-5)	Explosive mixture	[4]$1.035x10^{-10}$mmHg @25C/ [2]Solubility: Insoluble	[1]Moderate - High	[1]Moderate	[4]Soil: 92 Years [1]Biodegrade: moderate	[2]Carbon dioxide, carbon monoxide, nitrogen oxides.	F-86
Red Phosphorus (CAS 7723-14-0) (2500 lbs)	Agent Defeat warhead fill (PAD program testing)	[4]O.026 mm Hg @ 20 C/ [2]Insoluble	[2]High	Not Found	Not Found	[2]White phosphorus, oxides of phosphorus, phosphine, and phosphoric acid (if water is present) may be released if this material is heated to decomposition.	F-87

Test Material	Test Use	Vapor Presure/Solubility in Water	Soil Adsorption Tendency	Expected tendency for leaching	Degradation Rates	Hazardous Decomposition Products and By-Products	Discussion of Material
Pentolite (1000 lbs) (CAS 8066-33-9) (Pentaerythritol tetranitrate (PETN) & Trinitrotoluene (TNT))	Explosive mixture	[4]1.035x10-10mmHg @ 25C(PETN), [4]1.99x10-4 mmHg @ 20C (TNT)/ [2]Solubility: Insoluble	[1,5] Moderate - High (PETN)/High (TNT)	[1]Moderate	[4]Soil: 92 Years (PETN)/[4]1 year (TNT) [4]Aquatic: Volatilization river (model) 119 days [1]Biodegrade: moderate (PETN)/(TNT)	[2]Carbon dioxide, carbon monoxide, nitrogen oxide, formaldehyde, methanol, hydrogen cyanide, methane, ammonia, propane, ethane, solid carbon .	F-87
Trinitrotoluene (TNT) (500 lbs) (CAS 118-96-7)	Explosive mixture	[4]$1.99x10^{-4}$ mmHg @ 20C/ [3]Solubility: $1.3x10^{2}$ mg/L	[5]High	[5]Low	[4]Soil: 1 Year [4]Aquatic: Volatilization river (model) 119 days [1]Biodegrad: moderate [1]Photodegrad: slow (in water)	[2]Carbon dioxide, carbon monoxide, nitrogen oxides.	F-89
Tritonal (20,000 lbs) (TNT & Aluminum 80/20) (CAS 76-20-0)	Weapon warhead explosive (MOAB and Big BLU)	[4]$1.99x10^{-4}$ mmHg @ 20C (TNT)/[3]Solublilty $1.3x10^{2}$ mg/L --TNT [5]1 mm Hg @ 1284 C (Al)/[2]Insoluble in water -- (Al)	[5] TNT- High	[5]TNT- Low	[4]Soil: 1 Year [4]Aquatic: Volatilization river (model) 119 days [1]Biodegrad: moderate [1]Photodegrad: slow (in water)	[2]Carbon dioxide, carbon monoxide, aluminum oxide, solid carbon, ethane, ammonia, hydrogen cyanide, propane, acetylene, methane, methanol, ethylene.	F-90
White Phosphorus (CAS 7723-14-0) (2500 lbs)	Agent Defeat warhead fill (PAD program testing)	[4]O.026 mm Hg @ 20 C/ [2]Insoluble	[2]High	Not Found	Not Found	[2]White phosphorus, oxides of phosphorus, phosphine, and phosphoric acid (if water is present) may be released if this material is heated to decomposition.	F-87

Energetic/Reactive Materials

Aluminum (CAS 7429-90-5)	Explosive additive	[5]1 mmHg @ 1284 C(Al)/ Insoluble in water	[5]High	[5]Low	Natural occuring material	[2]Toxic metal fumes may form when heated to decompositon.	F-95
Ammonium Nitrate (CAS 6484-52-2)	Explosive additive	[2]17.2 mm of Hg (@ 20°C) based on data for: water(AN)/[2]118g/100 ml water @ 0^{o}C	[1]Low	[1]High	[4]Biodegrade: Fast (Anaerobic) [4]Soil: Not Available [2]Aquatic: readily biodegrade	[2]Emit nitrogen oxides when heated to decomposition. Librates ammonia in reaction with strong alkalis.	F-97
Ammonium Perchlorate (CAS 7790-98-9)	Explosive additive	Not Available/ [4]Solubility: 200 mg/L	Not Found	[4] Moderate	[4]Aquatic: It rapidly dissolves in water. Once dissolved, it becomes mobile in groundwater and can last for decades.	[2]Thermal decompostion may release toxic and hazardous fumes chlorine, hydrogen chlorides, ammonia, oxides of nitrogen.	F-98
Boron (CAS 7440-42-8)	Propellant & Explosive additive	[2]2.6 mmHg @ 20 C/ [3]Solubility: $5.0x10^{4}$ mg/L	[4]High (ph dependent)	Moderate to High (est)	[4]Soil and Aquatic : boron compounds transform to borates, no further degradation is possible in water. [4]Atmosphere: half-life of airborne particles is a matter of days, particle size dependent	[2]Loses chemically combined water upon heating, forming metaboric acid (HBO2), at 212-221 F, then pyroboric acid (H2B4O7) at 285-320 F, and Boric anhydrate at higher temperatures.	F-98
Hexachloroethane (CAS 67-72-1)	Test weapon additive	[2]0.21 mm Hg @ 20 C/ [1]Solubility: 50 mg/L	[8]High	[8]Low	[1]Soil: greater than 2 years [1]Atmosphere: 2.6 years [1]Aquaitc: model river 7 hours/model lake 180 hours	[2]Phosgene, carbon monoxide, irritating and toxic gases and fumes, carbon dioxide, and chloride fumes	F-100

Test Material	Test Use	Vapor Presure/Solubility in Water	Soil Adsorption Tendency	Expected tendency for leaching	Degradation Rates	Hazardous Decomposition Products and By-Products	Discussion of Material
Isopropyl nitrate (IPN) (CAS 1712-64-7)	Explosive additive	Not Available/ [3]Solubility: 3650 mg/L	Not Found	Not Found	Not Found	[2]Carbon monoxide, carbon dioxide, oxides of nitrogen, irritating and toxic fumes and gases.	F-101
Magnesium (CAS 7439-95-4)	Explosive additive	[2]1 Pa @ 428 C /[3]Solubility: $3.25x10^5$ mg/L	[4]Low (based on Mg ions)	[4]Moderate (Based on soil pH/soil type)	[4]Soil: Not Found [4]Atmosphere: Exist in the particulate phase [4] Aquatic: Not Found	[2]Toxic gases and vapors may be released if involved in fire.	F-102
Potassium Perchlorate (CAS 7778-74-7)	Explosive additive	Not Found/ [3]Solubility:$1.5x10^4$ mg/L	Not Found	Not Found	Not Found	[2]Chlorine and oxides of potassium.	F-103
Sodium Perchlorate (CAS 7601-89-0)	Explosive additive	No Found/[3]Solubility: $2.1x10^5$ mg/L	Not Found	Not Found	Not Found	[2]Hydrogen chloride,chlorine, oxides of chlorine	F-103
Teflon Polymer (Viton, Teflon) (PTFE)(CAS 9002-84-0)	Explosive additive	Not Found/[4]Insoluble	[4]Adsorb to suspended solids and sediment in the water column.	Not Found	[4]Soil: 3-10 Years/Volatilize 2.3-25 days [4]Atmosphere: 28 days Photochemically [4]Aquatic:7- 74 days (pH dependent) Photolysis	[2]Carbon monoxide, carbon dioxide, hydrogen fluoride, toxic gases and vapors may be formed during combustion.	F-104
Titanium (CAS 7440-32-6)	Explosive additive	[4]$1.0x10^{-79}$ atm @ 25 C /[4]Insoluble	Low	Low	Soil: No volatilization will occur	[2]Oxides of titanium, toxic and irritating fumes and gases.	F-104

Rocket Propellants

Test Material	Test Use	Vapor Presure/Solubility in Water	Soil Adsorption Tendency	Expected tendency for leaching	Degradation Rates	Hazardous Decomposition Products and By-Products	Discussion of Material
Ammonium Perchlorate/Aluminum/ binder propellants (AP/Al)	Propellant & Explosive additive	Not Found (AP)/ [2]Solublity in water: 20% (AP) [5]1 mmHg @ 1284 C(Al)/ [2]Insoluble in water (Al)	Not Found	Not Found	Not Found	[2]Thermal decompostion may release toxic and hazardous fumes chlorine, hydrogen chlorides, ammonia, oxides of nitrogen (AP)/ Toxic fumes and gases may form when heated to decomposition	F-107
Inhibited Red Fuming Nitric Acid (IRFNA) (CAS 7697-37-2)	Propellant & Explosive additive	[2]62 mm Hg @ 25C/ [3]Solubility: $9.09x10^4$ mg/L	[4]Moderate	[4]High	Not Found	[2]Various Nitrogen oxides, including NO, NO_2, N_2O_3,N_2O, all mixedwith nitric acid mist and vapor- can be can be produced upon decomposition or reaction with nitric acid.	F-107
Nitrate Ester propellants (Nitroglycerin - NG & Nitrocellulose - NC)	Propellant & Explosive additive	Not Found/[2]Slightly soluble in water (NG) [2]1 mmHg (nitroglycerin); 40mm (EtOH)/ [2]Insoluble in water (NC)	Not Found	Not Found	[1]Soil: (NC) 42 days/(NG) 2-7 days [1]Atmosphere: 1.76-17.6 hours (NG) [1]Aquatic:Surfacewater 2-7 days/Groundwater (NG) 4-14 days	[2]Carbon monoxide, carbon dioxide, nitrogen oxides and toxic fumes (NG). Carbon monoxide, carbon dioxide, nitrogen oxides methane., aldehydes, carboxylic acid, hydrogen cyanide (HCN)	F-109-110
Triamino-trinitrobenzeneTATB (CAS 3058-38-6)	Propellant & Explosive additive	[2]3.2 mmHg @ 175C /Solublity negligible	Not Found	Not Found	Not Found	[2]Phenol, dimethybenzene & several carboxylic acidsand phthalates	F-110
Unsymmetrical Dimethyl Hydrazine (UDMH) (CAS 57-14-7)	Propellant & Explosive additive	[2]103 mmHg/[3]Solubility: $1.0x10^6$ mg/L	[4]Dependent on soil composition	[4]High	[1]Soil: 8-22 days [1]Atmosphere: 0.8 - 7.7 hours photoxidation [1]Aquatic: a.Surface Water: 8-22 days b. Ground Water: 16-44 days	[2]Nitrogen oxides, carbon monoxide, irritating and toxic fumes and gases carbon dioxide, nitrogen	F-111

Non-Energetic Test Materials

Test Material	Test Use	Vapor Presure/Solubility in Water	Soil Adsorption Tendency	Expected tendency for leaching	Degradation Rates	Hazardous Decomposition Products and By-Products	Discussion of Material
Alumina (aluminum oxide) (CAS 1344-28-1) (600 lbs)	Rocket propellent	[2]0.75 mmHg @ 2158°C/ [1]Insoluble in water	[8]Low	[1]Low	Not Found	None Known	F-114
Benzyl mercaptan (CAS 100-53-8)	Test weapon additive	[2]71.8 mm Hg @120.766 C/ [4]Insoluble on water	Not Found	Not Found	Not Found	[2]Carbon monoxide, oxides of sulfur, irritating and toxic gases and fumes, carbon dioxide, hydrogen sulfide.	F-115
Boron trifluoride (BF3) (CAS 7637-07-2)	Test weapon additive	[4]10 mm & 40 mm Hg @ -141.3 & -131.0 deg C (solid) /[3]Solubility: $3.32x10^{6}$ mg/L	Not Found	Not Found	Not Found	[2]Decomposition products on cont act with aquatic or moisture: boro n compounds , hydrogen fluoride.Thermal decomposition products: organic acids, acid halides, halogenated, compounds.	F-116
Bromine (CAS 7726-95-6)	Test weapon additive	[2]100 @9.3 C/[2]4 g/100ml in water	High (est)	Low	Atmosphere: It has been recognized that, like chlorine, any bromine entering the stratosphere will also destroy ozone catalytically. The bromine cycle is believed to be more efficient in destroying ozone than is the chlorine cycle.	Hydrogen bromide.	F-118
Bromine Trifluoride (BrF3) (CAS 7787-71-5)	Test weapon additive	[2]0.931 kPa @ 20 C [3]Solublity: decomposes violently	Not Found	Not Found	Not Found	[2]Bromine, fluoride, bromine monofluoride, hydrogen flourine	F-119
Butyl mercaptan (CAS 109-79-5)	Test weapon additive	[2]83 mmHg @ 37.7 C/ [3]Solubility: 597 mg/L	[4]Low	Not Found	[4]Atmosphere: 1.6 days Photolysis [4]Aquatic: 5 hrs (river model) Volatilization	[2]Carbon monoxide, oxides of sulfur, irritating and toxic fumes and gases, carbon dioxide, hydrogen sulfide	F-120
Butyric Acid (CAS 107-92-6)	Test weapon additive	[2]0.43 mm Hg @ 20C/ [3]Solubility: $6.0x10^{4}$ mg/L	[4]Moderate	[4]High	[4]Soil: 8 days [4]Atmosphere: 8 days [4]Aquatic (river model): 59 days	[2]Carbon monoxide, irritating and toxic fumes and gases, carbon dioxide	F-122
Calcium Oxide (CAS 1305-78-8) (500 lbs per payload)	Test weapon additive	[2]Not Appicable/[2]Slightly soluble in water	High (est)	Low (est)	Naturally occuring in limestone.	[2]No hazardous decomposition products	F-123
Carbon fibers and nanotubes, various sizes	Test weapon additive	[4]1 mmHg @ 3586 C/ [2]Insolube in water	Not Applicable	Not Applicable	5730 years (C-14)	[2]Carbon monoxide and carbon dioxide	F-123
Cetyltrimethyl ammonium bromide (CAS 57-09-0)	Test weapon additive	[2]Negligible/10 % in Water	High (est)	Low (est)	Not Found	[2C]Carbon monoxide, carbon dioxide, nitrogen oxides, and hydrogen bromide gas.	F-124
Cetyltrimethylammonium chloride (CAS 112-02-7)	Test weapon additive	[1]Not found /Soluble	Low (est)	High (est)	Not Found	[2] Carbon monoxide, carbon dioxide,hydrogen chloride gas.	F-125
Chlorine (7782-50-5)	Test weapon additive	[2]5168 mmHg @21C/[2]1.46 % @ 0 C	Low	High (est)	Not Found	[2]Hydrogen chloride may form from chlorine in the presence of water vapor.	F-126
Chlorine Pentafluoride (CIF5) (CAS 13637-63-3)	Test weapon additive	2550 mmHg @ 20 C/ [2]Solubility is miscible	Not Found	Not Found	Not Found	[2]Hydrogen fluoride, chlorine gas.	F-126
Chlorine Trifluoride (CIF3) (CAS 7790-91-2)	Test weapon additive	[2]760 mm Hg @ 11.5 C/ [2]Decomposes in water	Not Found	Not Found	Not Found	[2]Hydrogen chloride, hydrogen fluoride,a variety of chlorine and fluoride compounds, hydrofluoric acid	F-127

Test Material	Test Use	Vapor Presure/Solubility in Water	Soil Adsorption Tendency	Expected tendency for leaching	Degradation Rates	Hazardous Decomposition Products and By-Products	Discussion of Material
Cyclohexyl mercaptan (CAS 1569-69-3)	Test weapon additive	[2]5 mbar @ 20 C/ [3]Solubility: 290mg/L	Not Found	Not Found	Not Found	[2]Carbon monoxide, oxides of sulfur, irritating and toxic fumes and gases, carbon dioxide, hydrogen sulfide	F-128
Ethyl 2-cyanoacrylate (CAS 7085-85-0)	Test weapon additive	[2]< 0.2 mm Hg/[2]Polymerize in water	Not Found	Not Found	Not Found	Not Found	F-128
Ethyl mercaptan (CAS 75-08-1)	Test weapon additive	[2]442 mm Hg @ 20 C/ [3]Solubility: $1.56x10^4$ mg/L	Low	Moderate	[4]Soil: rapidily [4]Atmosphere: 8Hrs Photochemically [4]Aquatic: 2.5 Hrs. (river model)/29 Hrs (Pond model) Volitzation	[2]Carbon monoxide, oxides of sulfur, carbon dioxide	F-129
Fog Oil (Naphthenic Oil) (CAS 64742-52-5)	Test weapon additive	[2]<0.0001 mm Hg @ 20 C /[2]Insolube in water	Not Found	Not Found	Not Found	[2]Carbon monoxide, carbon dioxide, irritating fumes and gases of aldehydes and ketones when heated to combustion	F-130
Glycerol (CAS 56-81-5)	Test weapon additive	[4]$1.58x10^{-4}$ mm Hg @ 25 C/ [3]Solubility:$1.0x10^6$ mg/L	[4]Low	[4]High	[4]Soil: High mobility [4]Atmosphere: 33 Hrs [4]Aquatic: degrades rapidly	Carbon monoxide, irritating and toxic fumes and gases, carbon dioxide	F-131
Hexachlorobenzene (CAS 118-74-1)	Test weapon additive	[4]$4.9x10^{-5}$ mm Hg @ 25 C/[1]Solubility: 0.0062 mg/L	[4]High	[4]Low	[1]Soil: 2.7-5.7 Years [1]Atmosphere: 156.4 days - 4.2 years [1]Aquatic: Surface Water: 2.7-5.7 Years/Ground Water: 5.3-11.4 Years	[2]Hydrogen chloride, carbon monoxide, carbon dioxide	F-132
Isopropyl mercaptan (CAS 75-33-2)F	Test weapon additive	[2]277.3 mm Hg @ 25C/ [3]Solubility: 4840 mg/L	[4]Low	[4]Moderate - High	[4]Atmosphere: 9 Hrs (Photochemically) [4]Aquatic: 2.7 Hrs (river model)/32 Hrs (lake model)	[2]Carbon monoxide, oxides of sulfur, irriating and toxic fumes and gases, carbon dioxide , hydrogen sulfide	F-134
[9]Magnesium Oxide, MgO (CAS 1309-48-4)/(2.20 lbs per test)	Test weapon additive	Not Found/[2]Insoluble in water	Not Found	Not Found	Not Found	[2]Not known to occur.	F-135
Mercaptoacetic acid (CAS 68-11-1)	Test weapon additive	[2]1 mmHg @ 60C/ [3]Solubility: $1.0x10^6$ mg/L	[4]Low	[4]High	[4]Atmosphere: 10 Hrs Photochemically [4]Aquatic: 130 days-2.4 Years	[2]Sulfur oxides, carbon monoxide, carbon dioxide, hydrogen sulfide	F-136
2-Mercaptoethanol (CAS 60-24-2)	Test weapon additive	[2]1 mmHg @ 20C/ [3]Solubility: $1.0x10^6$ mg/L	Not Found	[1]Leaching in soil is expected based upon 2-mercaptoethanol can evaporate to air from solid surface.	[4] Soil:biodegrade [4]Aquatic: 8.7 hrs photochemically	[2]Carbon monoxide, oxides of sulfur, irritating and toxic fumes and gases, carbon dioxide.	F-137
3-Mercaptopropionic acid (CAS 107-96-0)	Test weapon additive	[2]0.04 mm Hg @ 20C/ [3]Solubility: $1.19x10^5$ mg/L	Not Found	Not Found	Not Found	[2]Carbon monoxide, oxides of sulfur, carbon dioxide.	F-138
3-Methyl indole (CAS 83-34-1)	Test weapon additive	[2]1 mm Hg @ 95 C/ [3]Solubility: 498 mg/L	[4]Adsorb to suspended solids and sediments in water	[4]Low	[4]Soil: 35 days (Exp. Value) [4]Atmosphere: 0.64 hrs (Photochemically)[4]Aquatic: 20 river model/148 model lake/3.8 Hrs Photolysis	[2]Nitrogen oxides, carbon monoxide, carbon dioxide.	F-139
Methyl mercaptan (CAS 74-93-1)	Test weapon additive	[2]1536 mmHg @20 C/ [3]Solubility: $1.54x10^4$ mg/L	[4]Low	[4]High	[4]Atmosphere: 11.7 hrs Photochemically [4]Aquatic: volatization estimated 50 minutes model river/2.8 days model lake volilization	[2]Sulfur oxides, inorganic sulfates,nitrogen oxide, forms a crystal hydrate when mixed with water.	F-140

Test Material	Test Use	Vapor Presure/Solubility in Water	Soil Adsorption Tendency	Expected tendency for leaching	Degradation Rates	Hazardous Decomposition Products and By-Products	Discussion of Material
1-Methyl-1-propanethiol (CAS 513-53-1)	Test weapon additive	[2]142 mmHg @ 37.7 C/[3]Solubility: 1320 mg/L	Not Found	Not Found	[4]Soil: Fast [4]Atmosphere: 9-10.5 Hrs Photochemically [4]Aquatic: Volalitize (lake model) 3.8 days/(river model) 2.9 Hrs.	[2]Carbon monoxide, carbon dioxide, sulfur oxides.	F-141
2-Methyl-2-propanethiol (CAS 75-66-1)	Test weapon additive	[2]19.0 kPa @ 20C/ [3]Solubility: 2050 mg/L	[4]Not readily absorbed in soil/Not adsorb in water	[4]Moderate	[4]Atmosphere: 11-13 Hrs [4]Aquatic: river(model)2.9 hrs/lake(model) 3.8 days	[2]Carbon monoxide, oxides of sulfur, irritating and toxic fumes and gases, carbon dioxide, hydrogen sulfide.	F-142
Methyltrioctadecylammonium bromide (CAS 18262-86-7)	Test weapon additive	Not Found/Not Found	Not Found	Not Found	Not Found	[2]Carbon monoxide, carbon dioxide, nitrogen oxides, hydrogen bromide gas.	F-143
Methltrioctylammonium bromide (CAS 35675-80-0)	Test weapon additive	Not Found/Not Found	Not Found	Not Found	Not Found	[2]Carbon monoxide, carbon dioxide, nitrogen oxides, hydrogen bromide gas.	F-143
Methyltrioctylammonium chloride (CAS 63393-96-4)	Test weapon additive	Not Found/Not Found	Not Found	Not Found	Not Found	[2]Carbon monoxide, carbon dioxide, nitrogen oxides, hydrogen chloride gas.	F-144
1-Octanethiol (CAS 111-88-6)	Test weapon additive	[2]1.6 mmHg @ 20 C/[3]Solubility: 2.22x10[1] mg/L	Not Found	Not Found	[4]Soil: slight mobility [4]Atmosphere: Photochemically 8hrs [4]Aquatic: 3.36 hrs (model river)/4.8 days (model lake) volatilization	[2]Carbon monoxide, oxides of sulfur, carbon dioxide, hydrogen sulfide.	F-144
2,2'-Oxydiethanethiol (2-mercaptoethyl ether) (CAS 2150-02-9)	Test weapon additive	Not Found	Not Found	Not Found	Not Found	[2]Carbon monoxide, carbon dioxide, sulfur oxides, hydrogen sulfide gas.	F-145
Polyethylene glycol (CAS 25322-68-3)	Test weapon additive	[2]< 0.01 mmHg @ 20 C/ [3]Solubility: 1.0x10[6] mg/L	Not Found	[4]High	Not Found	[2]Carbon monoxide and carbon dioxide may form when heated t o decomposition	F-145
Terephthalic Acid (CAS 100-21-0)	Test weapon additive	[2]< 0.01 mm Hg @ 20 C/ [3]Solubility: 15 mg/L	Low	Moderate	[1]Soil: 1-7 days [1]Atmosphere: 9.7- 97 days [1]Aquatic: Surface Water: 1-7 days/Ground Water: 2-14 days	[2]Carbon monoxide, carbon dioxide, acrid smoke and fumes.	F-146
Tetraoctylammonium bromide (CAS 14866-33-2)	Test weapon additive	Not Found	Not Found	Not Found	Not Found	[2]Carbon monoxide, carbon dioxide,nitrogen oxides, hydrogen bromide gas.	F-147
Tetraoctylammonium chloride (CAS 3125-07-3)	Test weapon additive	Not Found	Not Found	Not Found	Not Found	[2]Carbon monoxide, carbon dioxide, nitrogen oxides, ammonia, hydrogen chloride gas.	F-148
Thiophenol (CAS 108-98-5)	Test weapon additive	[2]2 mm Hg @ 25 C/ [3]Solubility: 835 mg/L	[4]High	[4]Low	[4]BOD activated Sludge: 6 days [4]Atmosphere: Photochemically: 8.8 hours [4]Aquatic: volatize river (model): 3 hours/ lake (model) 5 days	[2]Sulfur oxides, carbon monoxide, carbon dioxide, hydrogen sulfide	F-148
Trimethylamine (TMA) (CAS 75-50-3)	Test weapon additive	[2]346 mm Hg @ 20 C/[3]Solubility: 8.90 x 10[5] mg/L	[4]Moderate	[4]High	[4]Soil:~4 hours [4]Atmosphere: ~ 4 hours [4]Aquatic: 11 hours (model) river partial volatization	[2]Nitrogen oxides, carbon monoxide, carbon dioxide, hydrocarbons	F-149
Tungsten (VI) Fluoride (WF6) (CAS 7783-82-6)	Test weapon additive	Not Found/ [2]Solublity:decomposes-reacts	Increases with debreasing pH	[4]Low	Not Found	[2]Hydrogen fluoride, tungsten compounds	F-151

Test Material	Test Use	Vapor Presure/Solubility in Water	Soil Adsorption Tendency	Expected tendency for leaching	Degradation Rates	Hazardous Decomposition Products and By-Products	Discussion of Material
Alternative Two							
Chemical Simulants							
Bis(2-ethylhexyl) phosphate (DEPHA) (CAS 298-07-7)(4000 gal)	nerve agent simulant; detector testing; decontamination testing	[4]$4.65x10^{-8}$ mmHg (est)/ [3]Solubility: 182 mg/L	[4]Moderately strong and the adsorption should become weaker as the pH of the media increases.	[4] Depends on both organic matter and clay content of soil and the sorption increases as the pH of soil decreases.	[4]Soil: Not Found [4]Atmosphere: 6.2 hr [4]Water: 2.4 days (Hydolysis)	[2]When heated to decomposition emits toxic fumes of phosphorus oxides.	F-152
2-Chloroethyl ethyl sulfide (CEES) (CAS 693-07-2)(4000 gal)	mustard simulant; detector testing	[4]3.4 mm Hg @25 C/ [3]Solubility: 1390 mg/L	[4]Low	[4]Moderate	[4]Atmosphere: 1 Day (Photochemically) Aquatic 44 seconds (Hydrolysis)	[2]Hydrogen chloride, carbon monoxide, oxides of sulfur, carbon dioxide, hydrogen sulfide, chloride fumes, 1,4-dithiane.	F-153
Diethyl methyl phosphonate (DEMP) (CAS 683-08-9)(4000 gal)	nerve agent simulant; detector testing; decontamination testing	Not Found/[3]Solubility: $3.4x10^4$ mg/L	Not Found	Not Found	Not Found	[2]Carbon monoxide, carbon dioxide, thermal decomposition may produce toxic fumesof phosphorus oxides and/or phosphine.	F-154
Diisopropyl fluoro phosphate (DFP) (CAS 55-91-4)(4000 gal)	thickened agent simulant	[4]0.579 mmHg @ 20 C/ [3]Solubility: $1.54x10^4$ mg/L	[4]Low	[4]High	[4]Soil: 16.7 hrs-2.2 days Hydrolysis [4]Atmosphere: 5 hours (Photochemically) [4]Aquatic: Volatilization model river 250 hr/lake120 days	[2]Phosphine, carbon monoxide, oxides of phosphorus, carbon dioxide, hydrogen fluoride.	F-154
Diisopropyl methyl phosphonate (DIMP) (CAS 1445-75-6) (4000 gal)	nerve agent simulant	[2]34 mmHg/[3]Solublity: 1500 mg/L	[4]High	[4]Moderate	[4]Soil: >365 days [4]Atmosphere: 3 days	[2]Orthophosphoric acid or orthophosphate salts	F-155
Tracer and Taggants							
Lead (II) Selenide, powder (CAS 12069-00-0)	taggant	Not Found/[2]Insoluble in water	[4]High (as Pb)	[4]Low (as Pb)	[4]Soil: will persist in the environment (as Pb)	[2]Lead/lead oxides, Selenium/selenium oxides.	F-156
Lead (II) Telluride (CAS 1314-91-6)	taggant	Not Found/[2]Insoluble in water	[4]High (as Pb)	[4]Low (as Pb)	[4]Soil: will persist in the environment (as Pb)	[2]Lead/lead oxides.	F-157
Mercuric Sulfide Red (CAS 1344-48-5)F	taggant	Not Found/[2]Insoluble in water	[4]High (as Hg)	[4]Low (as Hg)	[4]Soil: will persist in the environment (as Hg) [4]Atmosphere: volatize within a few days (as Hg)	[2]Toxic metal oxide fume sulfur oxides (SOx)	F-158
Mercury (II) Selenide (CAS 20601-83-6)	taggant	Not Found/[2]Insoluble in water	[4]High (as Hg)	[4]Low (as Hg)	[4]Soil: will persist in the environment (as Hg) [4]Atmosphere: volatize within a few days (as Hg)	[2]Toxic metal oxide fume, hydrogen selenide	F-159
Mercury (II) Telluride (CAS 12068-90-5)	taggant	Not Found/[2]Insoluble in water	[4]High (as Hg)	[4]Low (as Hg)	[4]Soil: will persist in the environment (as Hg) [4]Atmosphere: volatize within a few days (as Hg)	[2]Toxic metal fumes, mercury/mercury oxides	F-160

Footnotes:

[1] See references in Volumne II
[2] Information from Material Safety Data Sheets
[3] http://www.syrres.com/esc/free_demos.htm
[4] http://toxnet.nlm.nih.gov/
[5] http://www.atsdr.cdc.gov/toxpro2.html
[6] http://chemfinder.cambridgesoft.com/
[7] solvdb.ncms.org

APPENDIX I

SURFACE DEPOSITION OF A CHEMICAL SIMULANT (DMMP) FROM AN AERIAL RELEASE

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NORTHROP GRUMMAN
Information Technology

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12 October 2006

To: J. Fraher (DTRA\TDTS)

From: William R. Espander

Subject: Surface Deposition of a Chemical Simulant (DMMP) From an Aerial Release

Introduction\Summary

A test series was conducted at the Hazardous Spill Center, HSC, Nevada Test Site, NTS, Nevada, using three crop dusters to release the chemical simulant dimethyl methylphosphonate, DMMP, in December 2002. The release scenario was a total release of four hundred fifty-four kilograms of DMMP in a three hundred meter by fifty-five hundred meter target area. The simulant was released by three crop duster aircraft with a heading of 225° TRUE, a ground speed of 49 m/s, at altitudes of 366, 488, and 610 meters AGL.

The first test with a release of the chemical simulant was on 11 December 2002 at 1617 PST. The three aircraft released three hundred eighty-eight kilograms of DMMP. The simulant was tracked for fifty minutes by three Aerospace Corporation ground sensors and the airborne PIRANHA system.

An HPAC analysis was conducted for this test and the analytic results are compared with the experimental ground track in Figure 1. The analytic results compare well with the experimental results. The analytic results show a peak surface deposition of one hundred milligrams per square meter for a four hundred fifty-four kilograms release.

Discussion

The Divine Invader 03-02 test series was a series of aerial releases of a chemical simulant by crop dusters. The cloud formed by the simulant was tracked by sensors fielded by The Aerospace Corporation. The sensors included ground based passive infrared sensors and the airborne PIRANHA system to measure the location, size, and mass of chemical clouds. Three crop-duster releases were performed during the test series to disperse the nerve agent simulant dimethyl methylphosphonate (DMMP).

The test series was supported by an HPAC prediction cell that provided HPAC analysis pre-test based on forecast weather data and near real-time analysis based on weather observations. The weather observations included Rawinsonde balloon data, acoustic sounder upper air profiles, and surface station data.

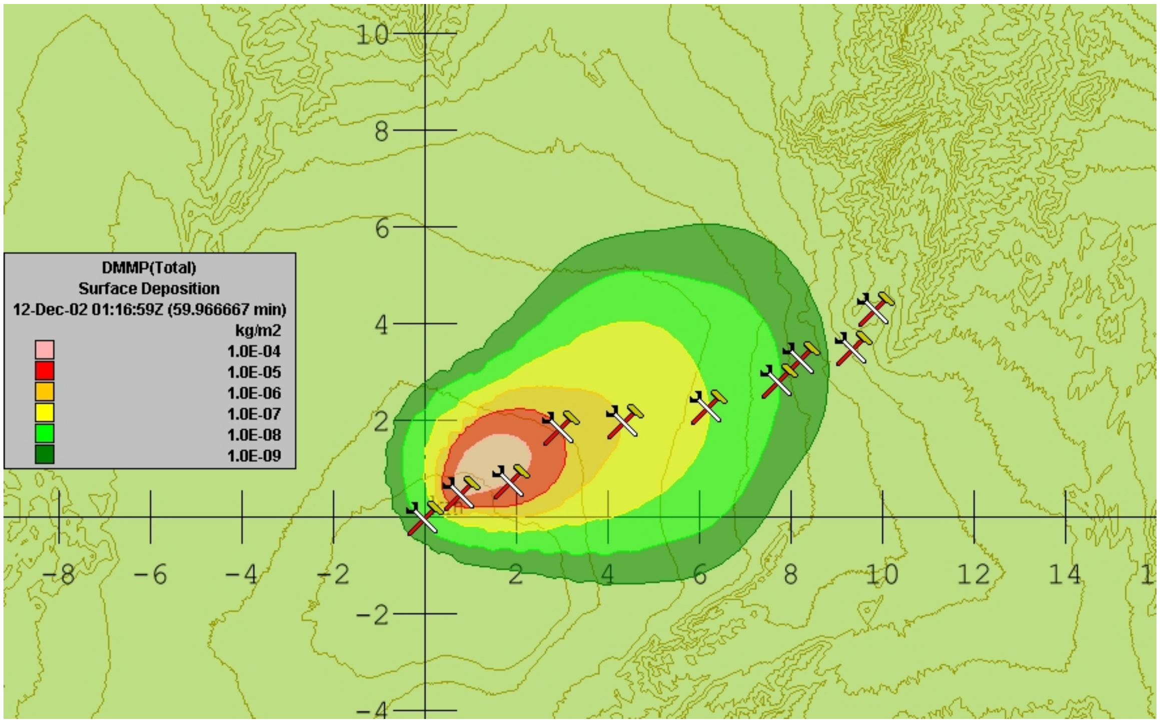

Figure 1 – DMMP surface deposition one hour after release.

The HPAC analysis assumed that the three aircraft released a total of four hundred fifty-four kilograms of DMMP in a three hundred meter by fifty-five hundred meter target area. The simulant was released along a heading of 225° TRUE, with a ground speed of 49 m/s, at altitudes of 366, 488, and 610 meters AGL. The releases were simultaneous with each aircraft distributing one-third of the simulant. HPAC calculations were made pre-test using forecast model data and near real-time using weather observations.

Weather observations included Rawinsonde balloon data, acoustic sounder upper air profile data, and surface station data. The Rawinsonde balloon was released one hour prior to simulant release time. Two upper air profilers were used and they updated on thirty minute intervals. Numerous surface stations are located at the Nevada Test Site and the data is updated on fifteen minute intervals. The HPAC calculations use all the observations in the temporal and spacial calculation domain.

The first chemical simulant test was conducted on 11 December 2002 with the release beginning at 1617 PST. The release was 11.219 s at 13.477 kg/s of 192 to 260 micron droplets. The crop duster atomizers are calibrated for a nominal 200 micron droplet size. Figure 1 shows a plot of surface deposition with the centroid location from The Aerospace Corp ground tracker results. The cloud centroids are represented by the crossed hammer and wrench symbol and progress from left to right. The first symbol is at the initial release point at time equal zero and moving to the right in five minute increments to forty-five minutes. The surface deposition tracks the centroid of the cloud as it moves. The figure also includes terrain contours, which shows the terrain changes at the test site. The maximum surface deposition is seen to be greater than one tenth but

less than one gram per square meter. Post test it was determined that three hundred eighty six kilograms of simulant was released.[1]

The surface concentration is shown Figure 2 with the cloud track centroids shown for reference. The peak concentration is greater than one-tenth but less than one milligram per cubic meter.

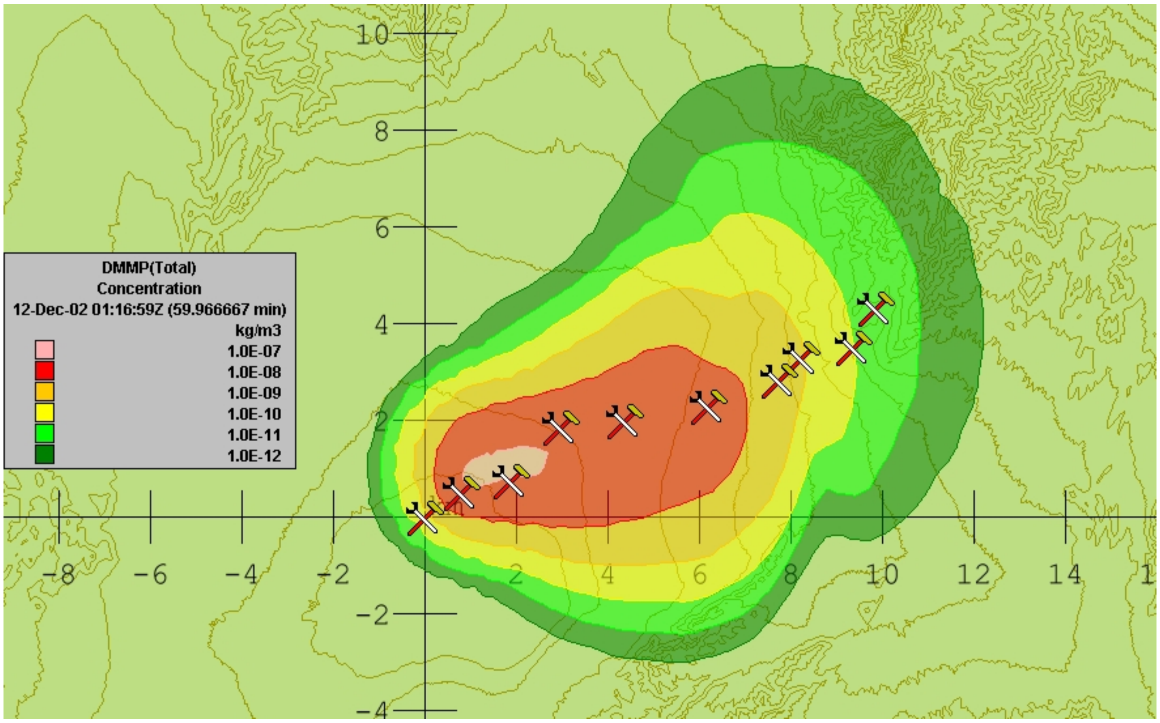

Figure 2 – DMMP surface concentration one hour after release.

Figure 3 shows the surface dose for this test. The surface dose is an integrated value of the exposure to the simulant at each location.

[1] C. S. Chang, et.al., DIVINE INVADER 03-02 TESTS, AEROSPACE CLOUD TRACKERS REPORT, The Aerospace Corporation, El Segundo, CA, December 2002

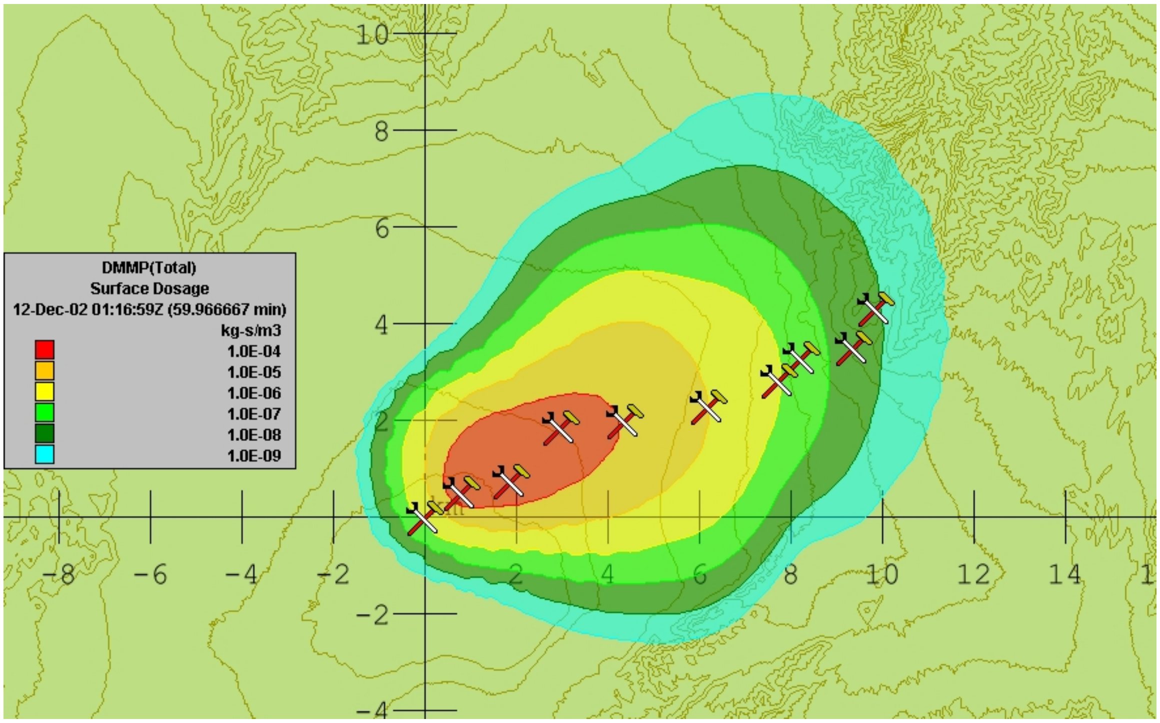

Figure 3 – DMMP surface dose one hour after release.

APPENDIX J

SURFACE DEPOSITION MODEL FOR PROPOSED CAPITOL PEAK COLLATERAL EFFECTS TESTING

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23 August 2004

To: J. Fraher (DTRA\TDTS)

From: William R. Espander

Subject: Surface Deposition from Capitol Peak Chem\Bio Releases on Habitat of White Sands Pupfish

Introduction\Summary

An HPAC analysis was conducted to determine the surface deposition of the biological simulant Bacillus globigii (Bacillus subtilis var niger), Bg, and the chemical simulant Dimethyl Methyl Phosphonate, DMMP, on the habitat for the State of New Mexico threatened species Cyprinidon Tularosa, White Sands pupfish. The releases were explosive disseminations from the Capitol Peak tunnel complex and the habitats of concern were Salt Creek, Malpais Spring, and Mound Springs on the White Sands Missile Range, NM, Figure 1.

A conservative approach was used to determine the material deposition at each of the habitats. Terrain and the wind field drive the material deposition. An HPAC terrain field was used and WSMR climatology data was used for the wind field[1]. There are preferred wind directions but there is a finite probability that the wind will be from a direction that moves the released material over the habitat, Figure 2. Historical wind speed data for Mocking Bird Gap shows that the highest wind speeds occur in late April, Figure 3.

The material is released by container-fragment interaction and is expelled from the tunnel structure by the gases resulting from the explosion. An Mk-82 GP bomb and an Mk-84 GP bomb were used in the calculations to determine the amount of material expelled from the structure. The higher energy available from an Mk-84 resulted in more biological material being neutralized by the hot gases from the explosion and larger viable biological simulant releases from the Mk-82. The Mk-84 resulted in a larger chemical simulant release than the Mk-82.

[1] Jeff Fraher, “WSMR Weather”, 15 July 2004.

The Bg surface deposition results using an Mk-82 and the worst case winds are shown in Figure 4. The maximum surface deposition of Bg at each habitat location is less than 0.1 $\mu g/m^2$. The DMMP surface deposition results using an Mk-84 and the worst case winds are shown in Figure 5. The maximum surface deposition for DMMP at each habitat location is less than 1.0 mg/m^2.

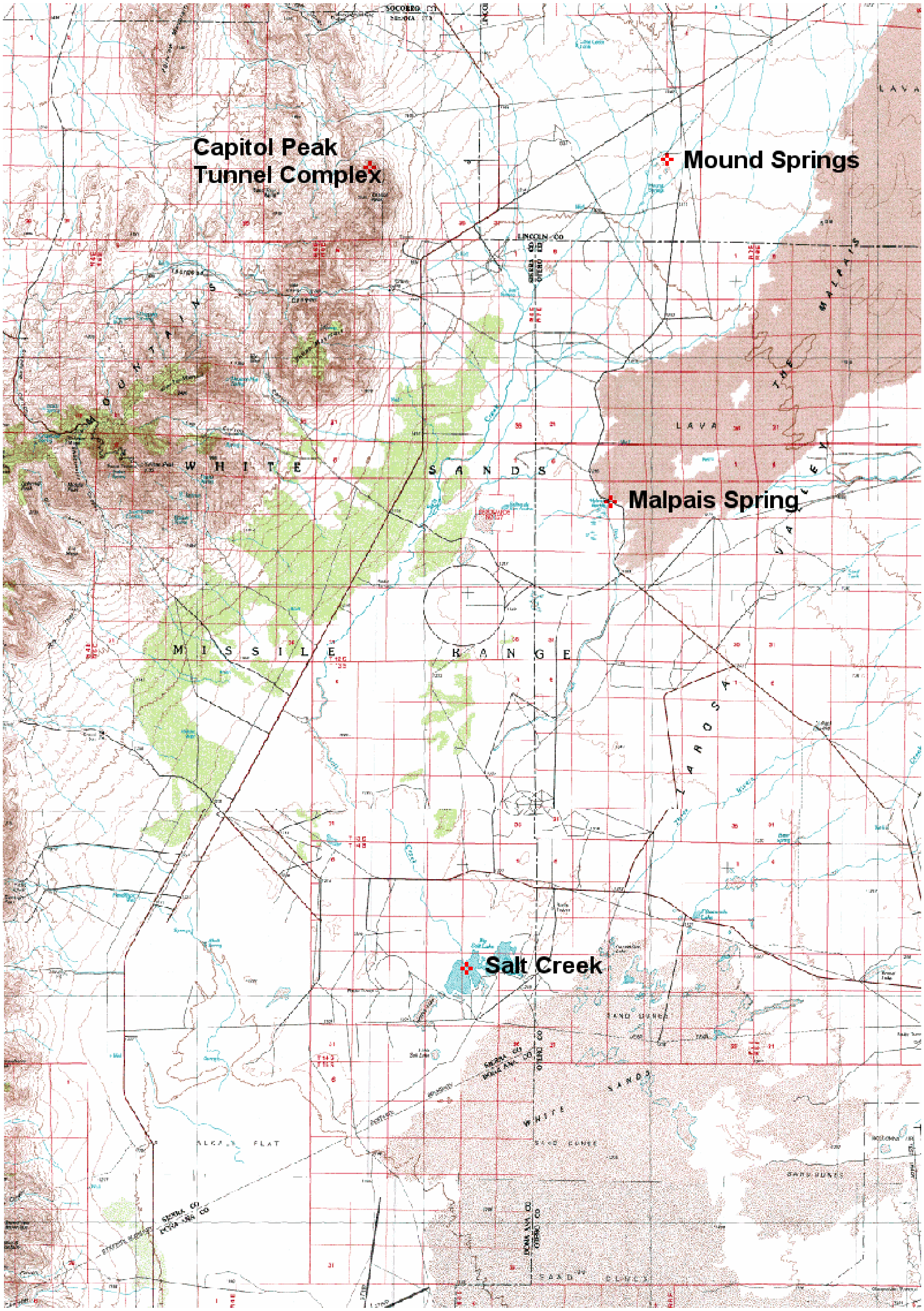

Figure 1 – Location of White Sands pupfish habitat relative to Capitol Peak tunnel complex.

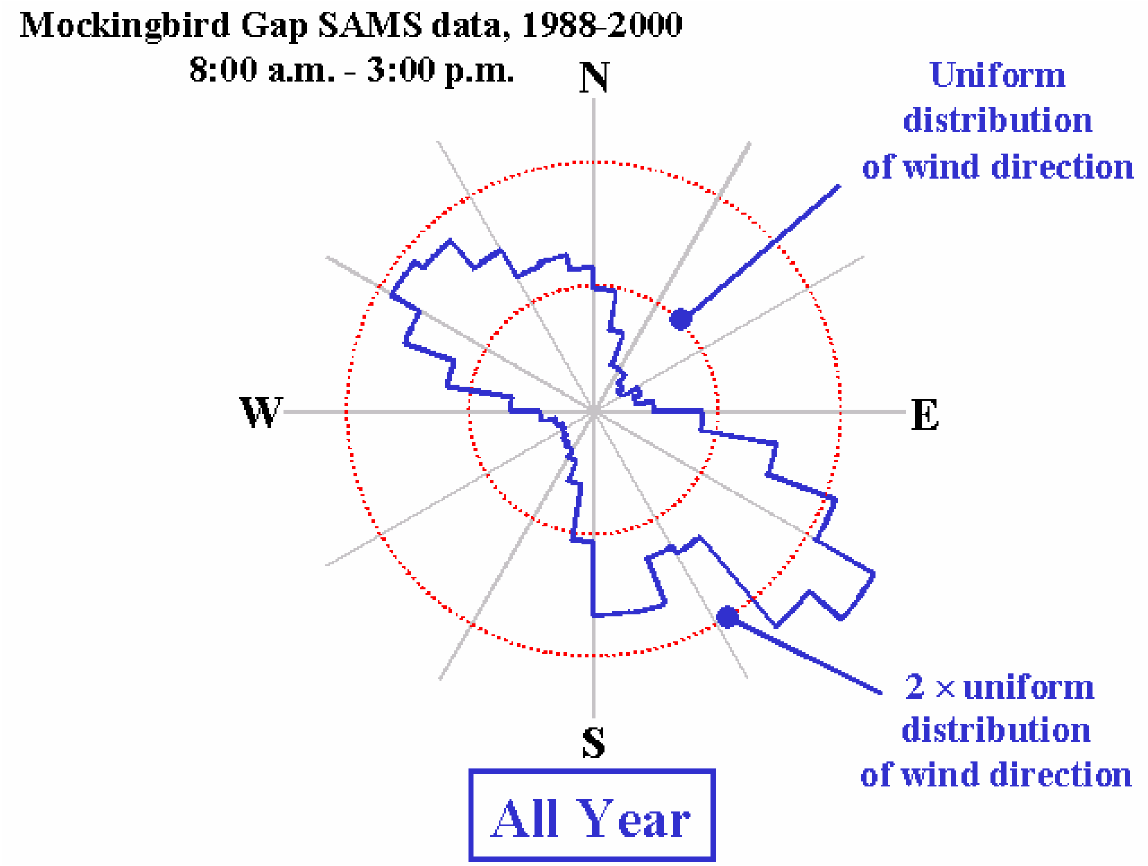

Figure 2 – Mocking Bird Gap probability of wind direction.

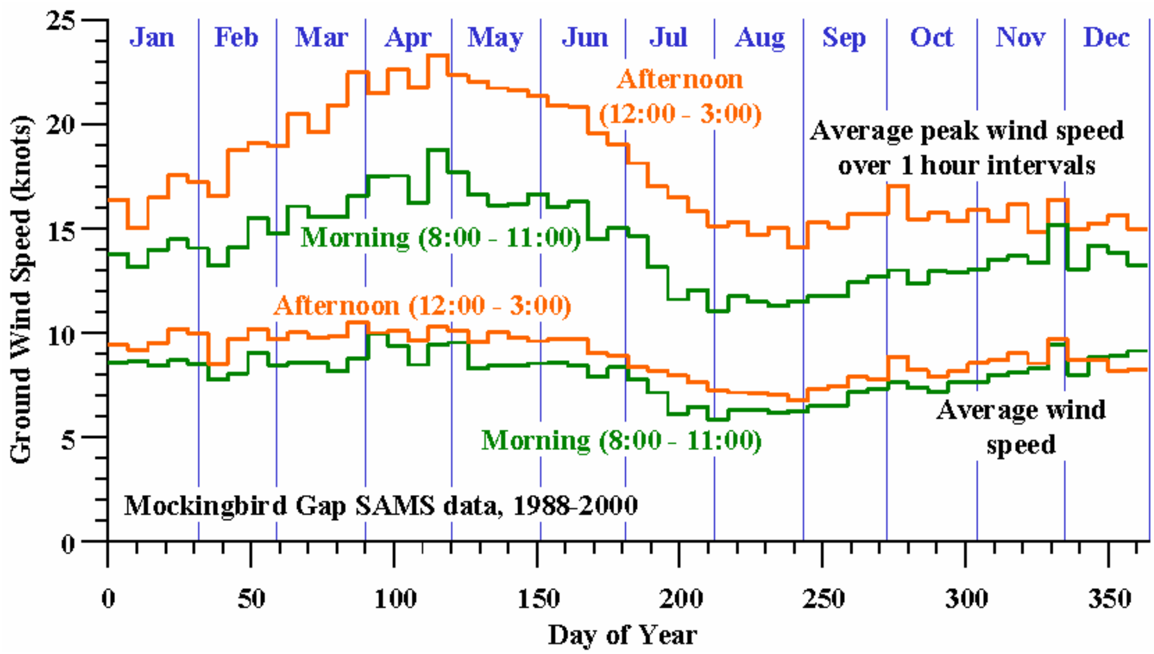

Figure 3 - Mocking Bird Gap one-hour wind averages.

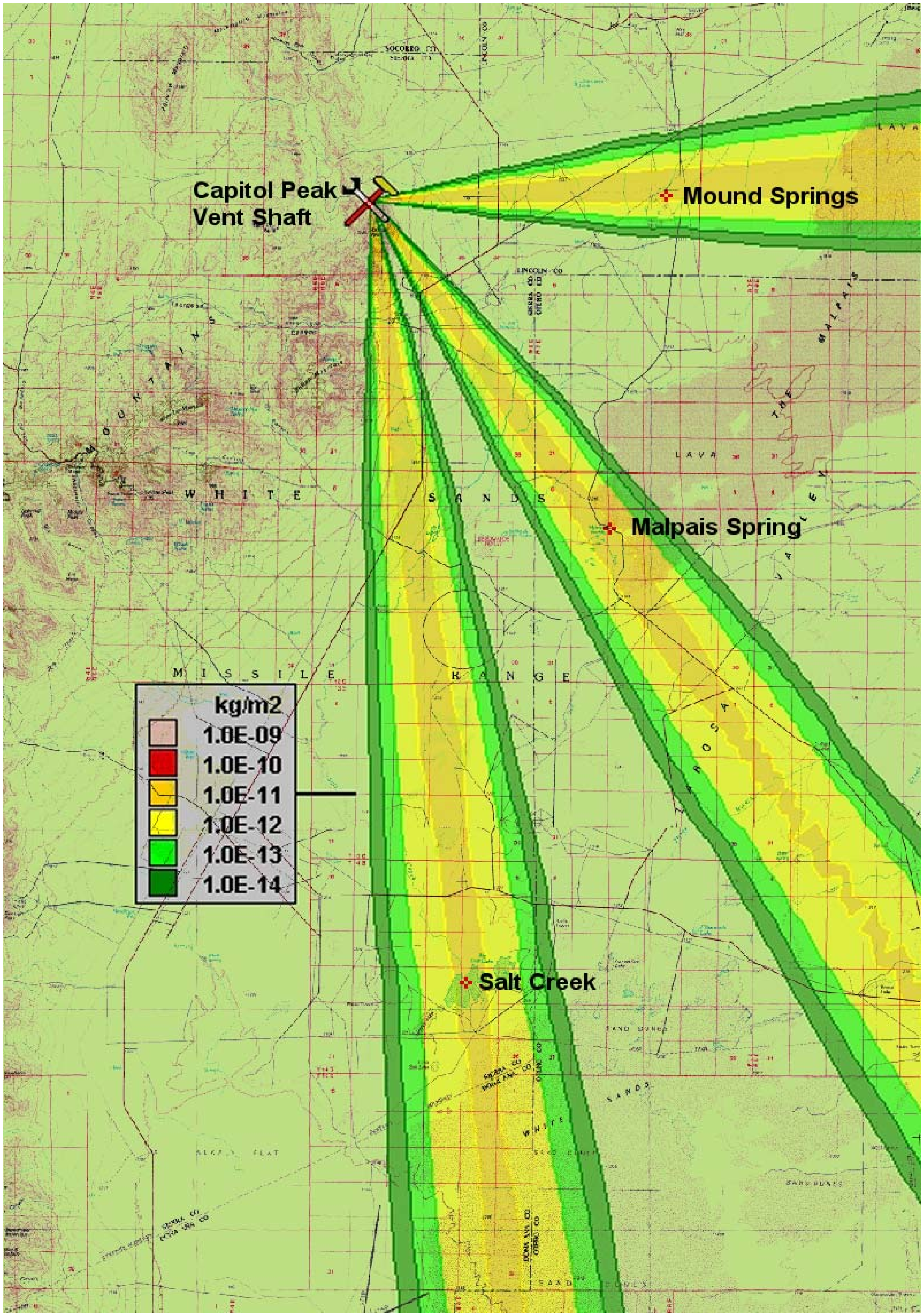

Figure 4 – Bg surface deposition.

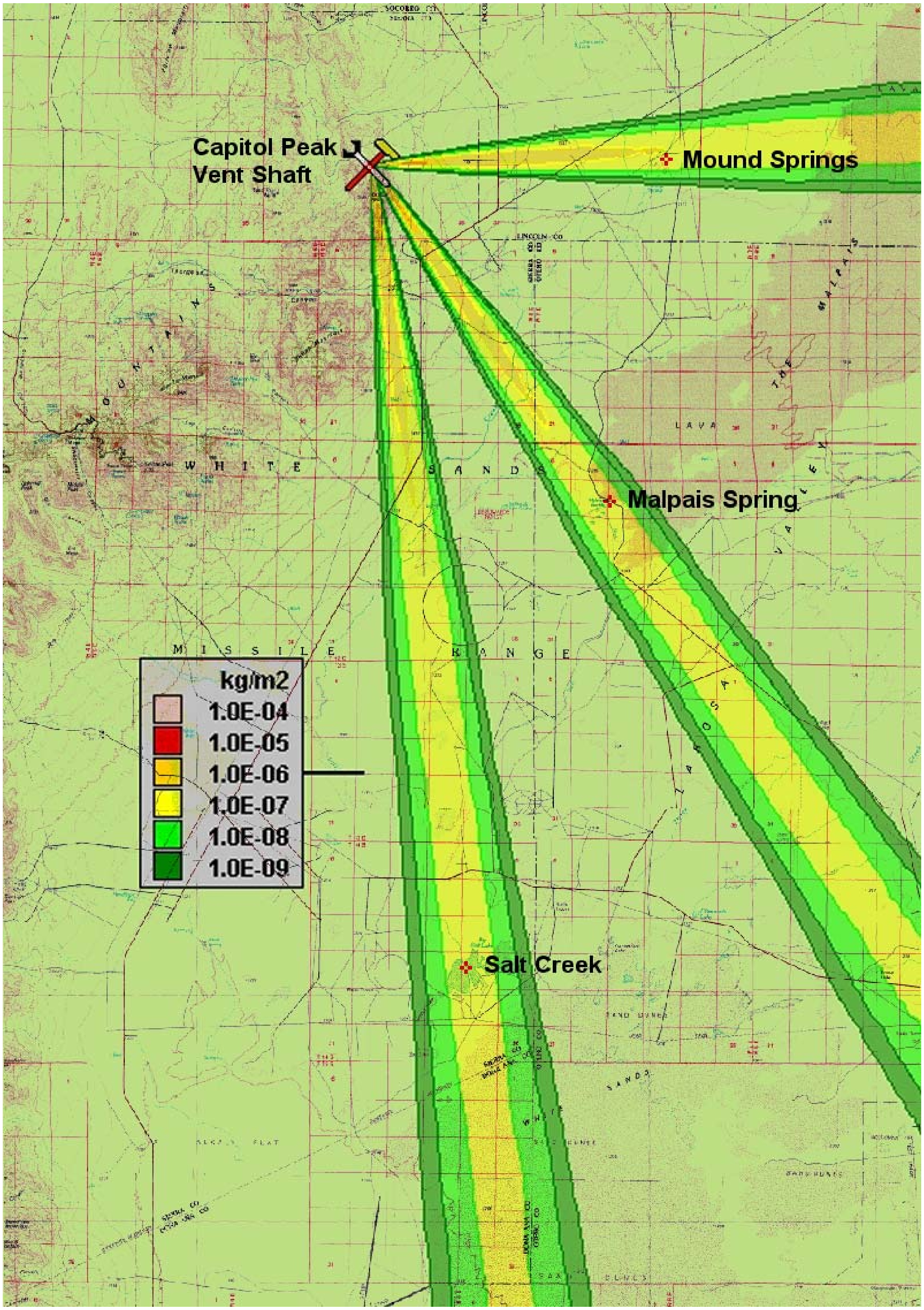

Figure 5 – DMMP Surface deposition.

Discussion

A conservative analysis approach was used to calculate the surface deposition of simulants released from the Capitol Peak tunnel complex on the habitat for the State of New Mexico threatened species Cyprinidon Tularosa, White Sands pupfish. The habitats of concern are Salt Creek, Malpais Spring, and Mound Springs on the White Sands Missile Range, NM, Figure 1.

The analysis approach used the expert user model STEP, STructural Expulsion Plume, model, to calculate the amount of material expelled from the tunnel complex. The results of the STEP calculation were used as the source term for an HPAC analysis. The HPAC analysis included terrain effects and surface meteorological effects based on the Mocking Bird Gap SAMS, Surface Automated Meteorological Station, data.

Tunnels A, B, the alcove, and vertical ventilation shaft were modeled in STEP as a series of rooms, connections, and pipes. It was assumed that the simulant was stored and the bomb detonated in the alcove. The amount of material released in the alcove is determined from the fragment-container interaction. The biological simulant was Bacillus globigii (Bacillus subtilis var niger), Bg, and the chemical simulant was DiMethyl Methyl Phosphonate, DMMP. The quantity of material stored in the alcove was either two hundred pounds of Bg or one thousand gallons of DMMP. Calculations were made for an Mk-82, eighty-seven kg of Tritonal, and an Mk-84, four hundred twenty-eight kg of Tritonal, warheads. The releases are summarized in the table.

Warhead	Simulant	Tunnel A (kg)	Tunnel B (kg)	Vertical Shaft (kg)	Total Vented (kg)
Mk-82	Bg	$1.8\ 10^{-3}$	$6.8\ 10^{-1}$	3.3	4.0
	DMMP	$2.2\ 10^{-10}$	$9.3\ 10^{-6}$	27.3	27.3
Mk-84	Bg	0.0	0.0	$4.6\ 10^{-12}$	$4.6\ 10^{-12}$
	DMMP	$2.1\ 10^{-3}$	3.9	241	245

As expected, the amount of material released from the tunnel portals is much less than the ventilation shaft. The amount of biological material released with the Mk-84 is nil because the heat from the explosion kills the material before the simulant can exit the structure. The amount chemical simulant released is larger for the Mk-84 because of the larger pressure source to drive the unburned material from the structure.

The Hazard Prediction and Assessment Capability, HPAC, analytic tool was used to propagate the released simulants downwind. The wind field and the terrain drive the downwind simulant deposition. An HPAC generated terrain file was used for the analysis and the wind fields were based on Surface Automated Meteorological System, SAMS, data from the Mocking Bird Gap station, footnote 1.

The location of the habitats is shown in Figure 1 and the wind direction for Mocking Bird Gap is shown in Figure 2. Figure 2 shows that the variability in wind direction is such

that the wind may be in the direction of a habitat. Therefore, the three wind directions were selected to maximize the surface deposition.

The annual variation in wind speed for Mocking Bird Gap is shown in Figure 3. The highest peak and average wind speeds occur during the afternoon in late April, therefore the afternoon of April 25 was selected as the test date and time. The highest concentrations and depositions occur when the winds are the highest. At lower wind speeds there is more meander and diffusion of the material resulting in lower concentrations and depositions. The three wind directions selected were two hundred sixty-eight, three hundred twenty-four, and three hundred fifty-three degrees. The wind speed was 12.1 m/s or 23.5 kts.

The Bg surface deposition is shown in Figure 4. Each of the habitats falls in the 1.0E-11 kg/m^2 contour. This contour represents values that are between 1.0E-11 and 1.0E-10 kg/m^2. The surface deposition of Bg is less than one-tenth $\mu g/m^2$ on the average. The DMMP surface deposition is shown in Figure 5. The contours show a surface deposition of less than one mg/m^2.

Updated 2006 HPAC Predictions for Essential Pupfish Habitat

In response to a request by New Mexico Department of Game and Fish in March 2006, additional HPAC analysis was conducted. This was done to determine the surface deposition of Bg and DMMP upon the nearest area to the Capitol Peak tunnel complex considered "Essential Habitat" for the White Sands pupfish. Results of the new modeling run are described in the following section (from the original report):

The HPAC calculations were updated to reflect an interest in the pupfish exposure level at an "Essential Habitat" located at E 374007.23 and N 3697195.37. A worse case calculation was made assuming that the wind was directed directly at the habitat. The results of the completed calculations are shown in Figures 6 and 7. Figure 6 shows the Bg exposure level to be less than 1e-10 but greater than 1e-11 kg/m^2, while Figure 7 shows the exposure level to DMMP are less than 1e-6 but greater than 1e-7 kg/m^2.

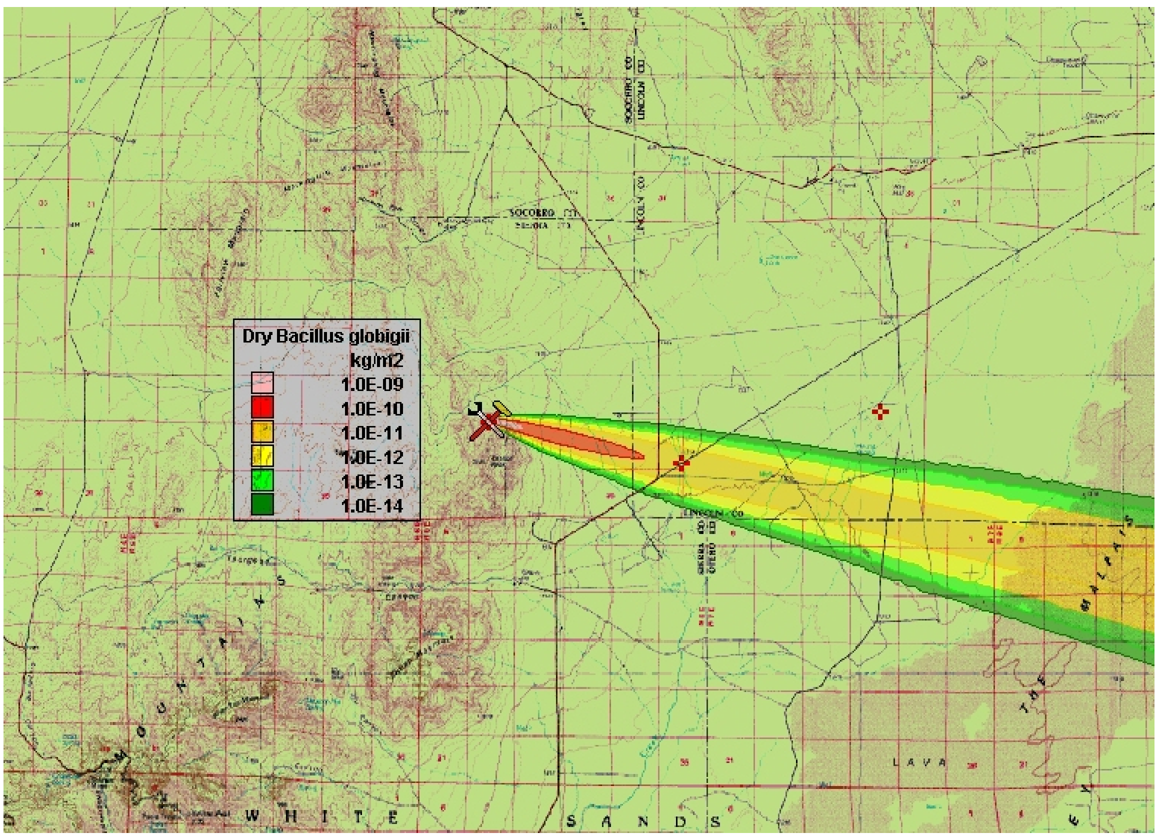

Figure 6 – Bg Surface deposition.

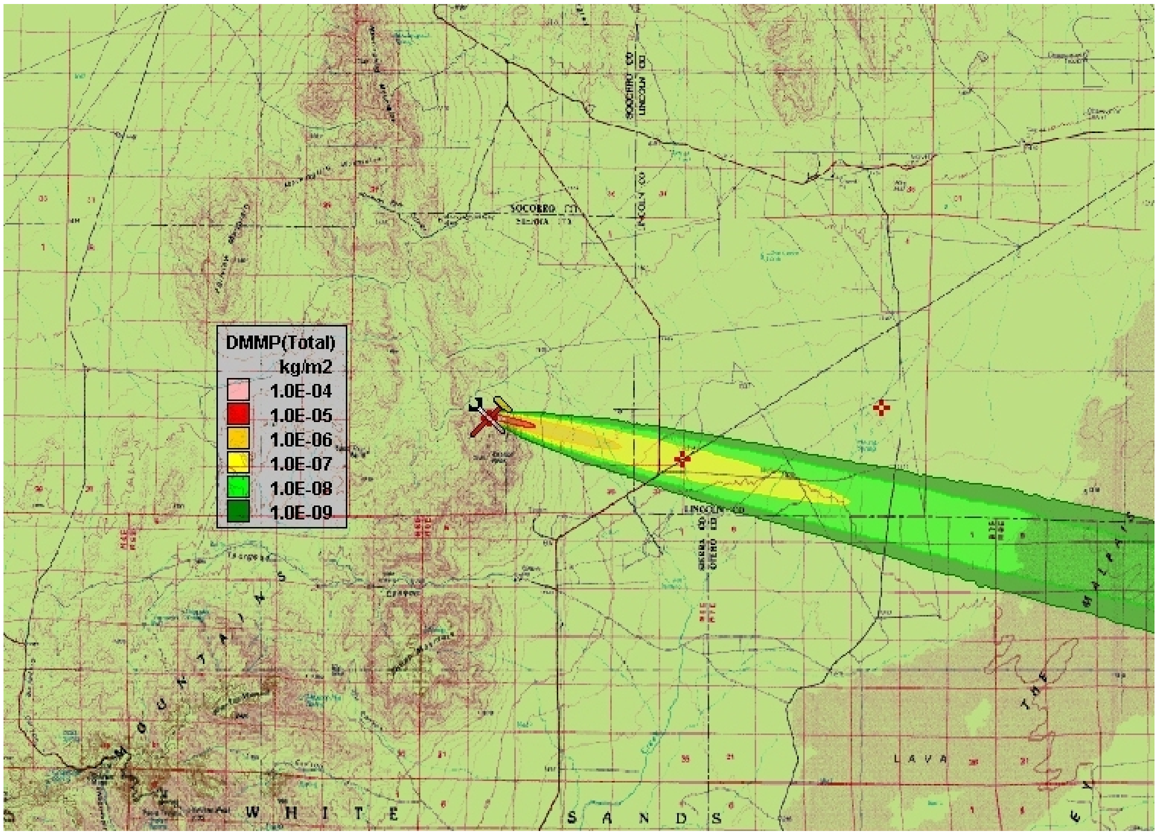

Figure 7 – DMMP Surface deposition.

APPENDIX K

FLORAL SPECIES OF INTEREST (SOI) ON WSMR

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White Sands Environmental Services Species of Interest	
COMMON NAME ***Scientific Name***	**HABITAT**
ACERACEAE – Maple Family	
Bigtooth maple *Acer grandidentatum*	This species very limited on WSMR, i.e. San Augustin Peak and Little San Nicolas Canyon. SANWR
AGAVACEAE – Agave Family	
New Mexico agave *Agave neomexicana*	This species is of ethno-botanical interest, this species grows in a wide band in the upper bajadas, especially in the San Andres Mountains and less so in the Organ Mountains. SANWR
Torrey yucca *Yucca torreyi*	There are about 12 documented stands on WSMR, all in the Southern San Andres Mountains or the eastern bajada of the Organ Mountains. SANWR.
AMARANTHACEAE – Amaranth Family	
Shrubby honeysweet *Tidestromia suffruticosa*	Occurs on limestone and gypsum-rich gravelly soils. Found only on a south facing hillside at San Nicolas Spring, Bennett Mountain.
APIACEAE – Parsley Family	
Threadleaf Indian parsley *Aletes filifolius*	Canyons and open slopes within pinion-juniper woodlands.
APOCYNACEAE – Dogbane Family	
Long-flowered amsonia *Amsonia longiflora*	This plant grows sporadically throughout the San Andres Mountains. The largest known population is found in Burris Valley.
Sand bluestar *Amsonia tomentosa* var. *stenophylla*	Common on quartzite sandy areas such as north of Orogrande Range Camp and along Range Road 7 between Connie and RAD Sites.
ASTERACEAE – Sunflower Family	
Spoonleaf rabbitbrush *Chrysothamnus spathulatus*	Occurs in piñion-juniper woodlands and lower foothills dominated by creosotebush. Found in reduced populations in the San Andres and Oscura Mountains. Probable on SANWR.
Dotted gayfeather *Liatris punctata*	Found only at one site on WSMR, on a knoll overlooking Pronghorn Valley on the eastern slopes of the Oscura Mountains.
Bigelow tansyaster *Machaerantha bigelovii*	Found in deep shaded areas in pinion-juniper woodlands of the Oscura Mountains.
Gyp daisy *Machaerantha gypsophila*	Found in deep shade in narrow canyons of the eastern Oscura Mountains.
Gypsumwort *Pseudoclappia arenaria*	Grows on gypsum soils at Mound Springs and Malpais Spring.

White Sands Environmental Services Species of Interest	
COMMON NAME ***Scientific Name***	**HABITAT**
ASTERACEAE – Sunflower Family (cont.)	
Threadleaf horsebrush *Tetradymia filifolius*	Occurs in limestone or highly gypsum bearing soils, usually in piñion-juniper woodlands. Found in mountainous terrain in the northern part of the San Andres Mountains and the Oscura Mountains.
BORAGINACEAE – Borage Family	
Payson's hiddenflower *Cryptantha paysonii*	Growing on limestone substrate in the eastern Oscura Mountains, Red Rio Bombing Range and Chupadera Mesa.
BRASSICACEAE – Mustard Family	
Fendler's rockcress *Arabis fendleri*	Occurs on rocky hillsides and rock crevices in full sun. So far only one population has been documented; this at the mouth of Lee Canyon in the San Andres Mountains.
Mustardwort *Thelypodiopsis purpusii*	Grows in the shade of large boulders and north facing cliffs. SANWR.
CACTACEAE – Cactus Family	
Chihuahuan fishhook cactus *Ancistrocactus uncinatus* var. *wrightii*	Found in the southern San Andres and San Agustin Mountains, more common on the west side on rugged rocky slopes. SANWR.
Sheer's pincushion cactus *Coryphantha scheeri* var. *valida*	Mostly on mid and lower bajadas of the southern San Andres Mountains, Mineral Hill, Antelope Hill, Little Goat Mountain and the Organ Mountains.
New Mexico hedgehog cactus *Echinocereus coccineus* var. *arizonicus*	Common on widely scattered alluvial fans and rocky outcrops throughout the San Andres and San Augustin Mountains.
Claret cup cactus *Echinocereus triglochidiatus*	Frequent on lower bajadas and plains in the Tularosa and Jornada del Muerto Basins and interconnected gaps (Oscura and Mocking bird).
Button cactus *Epithelantha micromeris* var. *micromeris*	Growing in limestone cracks in the Big Gyp Hills, San Andres Mountains, and little Burro Mountains. SANWR.
Southwestern barrel cactus *Ferocactus wislizenii*	Common on the bajadas of the Organ and San Andres Mountains and Mineral Mountain, Parker Hill, Antelope Hill and San Augustin Mountains.
Pineapple cactus *Neolloydia intertexta* var. *dasyacantha and* var. *intertexta*	Both of these varieties are found from the San Augustin Mountains to the Oscura Mountains, usually on mid to upper bajadas. SANWR.
Pancake prickly pear *Opuntia chlorotica*	Occurs on steep slopes and granitic outcrops. Found only on Antelope Hill near WSMR Main Post.

White Sands Environmental Services Species of Interest	
COMMON NAME *Scientific Name*	**HABITAT**
Club cholla *Opuntia clavata*	Common in the northern part of White Sands Missile Range especially Jornada del Muerto Basin, and the northern part of the Tularosa Basin.
CACTACEAE – Cactus Family (cont.)	
Gramagrass cactus *Pediocactus papyracanthus*	A very cryptic species commonly found in the southern half WSMR associated with alkali sacaton, burrograss, dropseeds, and grama grasses. Found infrequently on Jornada del Muerto at PHETS and on the western bajada of Mockingbird Mountain.
COMMELINACEAE – Spiderwort Family	
Wright spiderwort *Tradescantia wrightii*	Occasionally found in the Oscura and San Andres Mountains in grassland or riparian areas. Probable on SANWR.
EPHEDRACEAE – Joint-fir Family	
Cory jointfir *Ephedra coryi*	Occurs on rocky ridges in the Oscura Mountains and Mockingbird Mountains
EUPHORBIACEAE – Spurge Family	
Candelilla *Euphorbia antisyphilitica*	Found on dry, gravelly limestone hills.
FABACEAE-Legume Family	
La Jolla prairie clover *Dalea scariosa*	Uncommon on ridges in the eastern part of the Oscura Mountains, in the Mocking bird and Fairview Mountains, and west of Salinas Peak.
GENTIANACEAE- Gentian Family	
Tall prairie gentian *Eustoma exaltatum*	Locally common at Mound Springs, Malpais Spring and Tularosa Creek drainage.
HYDROPHYLLACEAE-Waterleaf Family	
New Mexico scorpionweed *Phacelia neomexicana* var. *neomexicana*	Mostly in the southern part of WSMR, an ephemeral springtime species.
LAMIACEAE-Mint Family	
Supreme sage *Salvia summa*	Partial shade in canyons and on rocky slopes
Scarlet hedgenette *Stachys coccinea*	Growing in Texas Canyon and Ash Canyon in the Organ Mountains.
LILIACEAE – Lily Family	
Evening rainlily *Cooperia drummondii*	Mountain meadows
Copper zephyr lily *Zephyranthes longifolia*	Appearing after heavy rains on the east facing bajadas of the Organ and San Andres Mountains.
LOASACEAE – Stickleaf Family	
Gypsum blazing star	Found in the Gyp Hills and Chalk Hills of the

White Sands Environmental Services Species of Interest	
COMMON NAME ***Scientific Name***	**HABITAT**
Mentzelia perennis	middle San Andres Mountains.
MALVACEAE – Mallow Family	
Hot Springs globemallow *Sphaeralcea polychroma*	Common in the northern Stallion area in the Jornada del Muerto Basin and in the northern Tularosa Basin.
PLUMBAGINACEAE – Plumbago Family	
Trans-Pecos sea lavender *Limonium limbatum*	Found in the Malpais Spring drainage area and the Tularosa Creek drainage area including Brazel Lake.
POACEAE (Gramineae) – Grass Family	
Mohave panicgrass *Panicum mohavense*	Found only once at the base of west facing cliffs below North Oscura Peak.
PORTULACACEAE-Purslane Family	
Long-stemmed flame flower *Talinum longipes*	Rarely seen plant growing on limestone bedrock in the Oscura Mountains and the Mockingbirds.
RANUNCULACEAE – Buttercup Family	
Yellow columbine *Aquilegia chrysantha*	An obligate wetlands species, common around seeps and springs in the San Andres Mountains.
RHAMNACEAE – Buckthorn Family	
Wright's mock buckhorn *Sageretia wrightii*	Uncommon in the Oscura Mountains.
ROSACEAE – Rose Family	
Desert serviceberry *Amelanchier utahensis*	Known only at Ropes Spring, west of San Andres Peak. SANWR.
Desert rose *Rosa stellata* var. *mirifica*	Common in the higher elevations of the northern San Andres and Oscura Mountains.
SCROPHULARIACEAE – Figwort Family	
New Mexico penstemon *Penstemon neomexicanus*	Uncommon in the Oscura mountain meadows.
STERCULIACEAE – Cacao Family	
Little-leaf ayenia *Ayenia microphylla*	Only known on WSMR in the Lost Man Canyon drainage of the middle San Andres Mountains.

SANWR = San Andres Wildlife Refuge

APPENDIX L

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